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Metals and Alloys

THE GAZINE OF METALLURGICAL ENGINEERING

PRODUCTION · FABRICATION · TREATMENT · APPLICATION

MARCH 1942

MAGNESIUM

(Top Left) Trimming operation on DOWMETAL aircraft radio masts.

(Center) Finishing operation on DOWMETAL wheel fairings.

(Right) Spot welding operation on DOWMETAL tank baffle.

(Lower Left) Riveting operation on fabricated DOWMETAL part.

DOW OFFERS COMPLETE FACILITIES FOR FABRICATION OF DOWMETAL PARTS

The parts shown here are some of the many DOWMETAL* sub-assemblies which are being produced in our DOWMETAL Fabrication Division. Complete facilities for forming, welding, riveting and assembling are available and are daily producing vital airplane parts for the nation's Victory Program.

Such items as wheel parts, oil and hydraulic fluid tanks, radio masts, oxygen cases, furniture and fixed equipment are all suitable for fast, economical production in DOWMETAL.

With recently expanded production units, Dow is in a position to offer facilities for the immediate fabrication of parts in dependable weight-saving DOWMETAL.

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MAGNESIUM ALLOYS

LIGHTEST OF ALL STRUCTURAL METALS

INGOT • CASTINGS • FORGINGS • SHEET • STRIP • PLATE • EXTRUSIONS

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Feature Articles

Magnesium Alloy Castings for Aircraft

War-production emphasis has suddenly switched to *now* as distinct from *two years from now.* Magnesium alloy castings, vital to the fighting aircraft of our country, are *now* being mass-produced at Ford's new magnesium alloy foundry at Dearborn, and E. F. Cone (page 396) describes the practice employed in melting, casting and heat treating them.

More Reference Tables on Alternate Materials

Two specially prepared reference tables (section 2 of the general series started in January) present alternates and substitutes for scarce metals and alloys used in motor vehicle parts. The substitutions suggested can be intensively applied in the automotive industry's all-out production of combat and transport vehicles, replacement parts and aircraft, and can be carried over into other fields as well.

Brake Drums

Having discussed the service factors that govern the performance (and selection) of brake drum materials in the first instalment of his article last month, Oliver Smalley presents in the second instalment in this issue (page 405) the results of scoring and thermal-check tests on 4 different types of cast iron.

Low-Tin Solders

Tin is fast climbing toward the top of the list of critical metals, and its scarcity will be most painfully felt in the field of solders, used as they are in practically all industries. A possible solution is offered by S. Turkus & A. A. Smith, Jr. (page 412)—new low-tin (15-20 per cent Sn) solders containing silver and bismuth that have good flowing properties and satisfactory bond and creep strengths.

A Rotating Induction Furnace

Many of our recent advances in steelmaking practice have been the direct result of investigations of the reactions between molten steel and the slag in contact with it. A very practical aid to such studies (and another step forward for the induction method of heating) is the rotating induction furnace, described completely by F. W. Scott & T. L. Joseph (page 414).

Phosphate Coatings on Steel

Quite aside from their normal utility as a surface finish or as a base for other finishes, phosphate coatings are now rapidly extending their applications in the munitions field and as substitutes for hard-to-get metal coatings of various types. It is especially timely, therefore, to have Herbert Chase's (page 420) survey of modern engineering applications of phosphate coatings from the standpoint of product design and service requirements.

Metallurgical Engineering Digests

Electrolytic Iron Sheets

Large-scale manufacture of workable iron by electrolytic methods that circumvent the liquid stage has challenged the imagination of many people. The direct production of iron sheets by electrodeposition of non-porous ductile iron on suitable cathodes is investigated by Muller & Witnes (page 466).

Reclaim Your Aluminum!

Although few shops are recovering more than 75 per cent of the aluminum in dirty turnings, recovery *can* be as high as 90-95 per cent from clean turnings, declares Eyles (page 473) in a survey of practice in salvaging aluminum scrap.

Spotlight on Spot Welding

Spot welding is "going places" fast, as is evident from a composite digest on spot welding, starting on page 478. Special progress in control and in the spot welding of nickel alloys is reported.

Rubber Press-Forming Tools

American aircraft engineers are making intensive and advantageous use of the Guerin process, which employs rubber pads as part of the die set, for forming sheet metals. A composite digest on page 487 gives interesting descriptive details on the most efficient use of rubber for press forming.

What! "18 and 8" Stainless Not Austenitic?

Think of the thousands of articles, pamphlets, commercial literature, specifications, etc. that would have to be rewritten to eliminate the word "austenitic" and to revise structural classifications if it were officially promulgated that "18 and 8" stainless is not an austenitic type of stainless at all. Yet that is what Uhlig (page 510) claims, as the result of an investigation that showed very pure "18 and 8" to be ferritic at room temperature in the complete absence of nitrogen.

Light Metals in Transport Vehicles

If there were more aluminum and magnesium available, the recommendations of Tylecote (page 516) for using light alloys to great advantage in heavy transport vehicles would be widely applied. Anyway, they're worth preserving until that certain curse is wiped from the brows of men and we can resume our normal methods of design.

Radiography in a Nutshell

The above heading is probably the title that should have been given to Betteridge's (page 522) broad but concise review of industrial radiographic technique, except that nutshells are about the only things into which X-ray machines or radium are not poked these days.

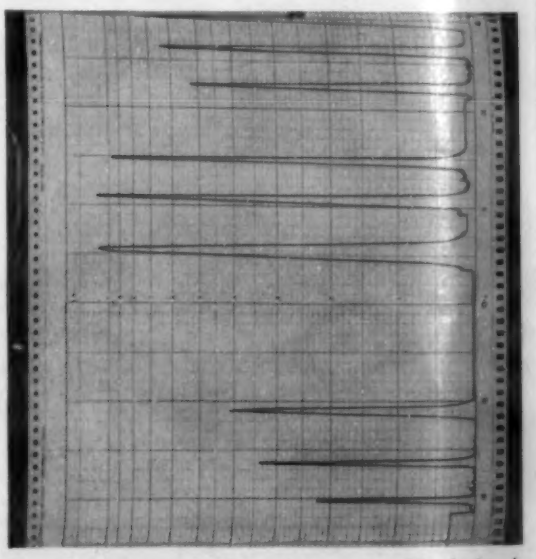
Microphotometer in an industrial laboratory. Scanning Unit in foreground, Speedomax Recorder in back.

Recording Microphotometers Speed Up Metal Analyses

About 500 non-ferrous alloy samples come in daily for analysis in each of the laboratories of a certain metal-producing company. On some of these samples, as many as nine quantitative determinations are made.

With this heavy volume of laboratory work to handle, the company has turned mainly to spectrographic analysis. They find that the speed and economy of this method "could not be approached by wet chemical methods" and the accuracy is so high that spectrographic results are even superior to chemical ones, in many cases.

To use the spectrograms for quantitative analysis, it is necessary to measure the density and position of their lines. This task is now done automatically; lines are measured and recorded by Knorr-Albers Recording Microphotometers, which have been so successful that each laboratory has at least one instrument.



Speedomax record of a spectrogram. Vertical position of each "spike" on the chart identifies a constituent in the sample; horizontal amplitude, when referred to calibration curves prepared by the user, gives percentage of the constituent.

An outstanding advantage of the equipment is that it does not involve photographic recording or the use of a high-sensitivity galvanometer. The entire measuring process is automatic: the user simply clamps the spectrogram in place, adjusts the controls, starts the mechanism—and the Speedomax draws an amplified record of the spectrographic lines.

If you'd like further information on the equipment, write for Catalog E-90(1).

Here's PYROMETER SERVICE For Forced-Draft Production!

The applications of Micromax Pyrometers to temperature control have been worked out in such detail as to require nineteen separate publications to describe them.

Back of these books is a staff of scores of men who have made temperature-control their life work.

Therefore, if it's pyrometer information you want, we can supply it. In detail. With clean-cut, crisp recommendations. And promptly.

The control equipment on which this service is based is the Micromax family of pyrometers. They are micro-responsive—they act in most cases long before a man could act, to regulate a temperature. They can turn heat sharply up and down, if your process requires abrupt action. Or, they can "throttle" it, gently but steadily, matching every tiny temperature change with the exactly correct change in fuel supply, so that temperature, and hence product quality as affected by temperature, are constant.

Micromax Pyrometers are made in 5 models; and for either electrically-driven or diaphragm-type valves; for either thermocouples or our Rayotube radiation detecting elements. Several hundred standard ranges are available . . . to receive further information, just outline your problem.

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What to Do With the Tin-pots?

If we were running an industrial museum, we'd get a tin-pot for the metallurgical collection, while tin-pots are still to be found. The hand-puddling furnace for wrought iron is moving over, on the shelf of history, to make room for the tin-pot which will join it in the limbo of discarded processes.

The tin-pot, in order to make sure that the most thinly coated spot receives 0.7 lb. per base box, uses an average of around 1.25 lb. per base box, the more heavily coated portions doing no good, since the behavior is governed by the thinnest spot. The tin-pot doesn't want to produce thinner coatings than around 1.10 lb. per base box average, and it delivers quite a part of the coating as a none-too-ductile iron-tin alloy layer. Moreover, the tin-pot prefers to handle small sheets one by one and balks at cooperating with the designer of a continuous strip-tinning outfit. It was actually out-moded when cold-reduced strip supplanted pack-rolled hand mill black plate.

Continuous electrolytic tinning is free from these faults and has fundamental advantages as a production method. Moreover, it avoids the grievous waste in the useless spots of heavy coating, and it allows coatings of only a few tenths of a pound per base box, which features make its development imperative for conservation of tin. Once the development is perfected and widespread operating experience is gained, electrolytic tinning should prove so economical that even if the tin situation should shift to an ample supply and a 30c price, return to hot tinning of plate would be highly unlikely.

As electrolytic tinning lines sufficient to handle the demand are installed, and the tin-pots released, the question will arise whether the tin-pots can be applied to any other useful purpose.

—H.W.G.

Remembering Pearl Harbor

Americans can do more with one good slogan (or *vice versa*) than with a hundred resolutions or proclamations. "Keep 'Em Flying!"—the theme of a thousand variations—has earned its stripes as a production booster. Late last year it was joined by a real mountain-mover, "Remember Pearl Harbor!", which seems destined to occupy a more conspicuous place in the history books than even "Remember the Maine!" and "Make the World Safe for Democracy!"

It now appears that there are many more reasons for remembering Pearl Harbor than just the original one of keeping ourselves so mad at the Japanese and their European mentors that nothing will be allowed to hamper our progress toward victory. For with the evidence of the Roberts' report in mind, "Remember Pearl Har-

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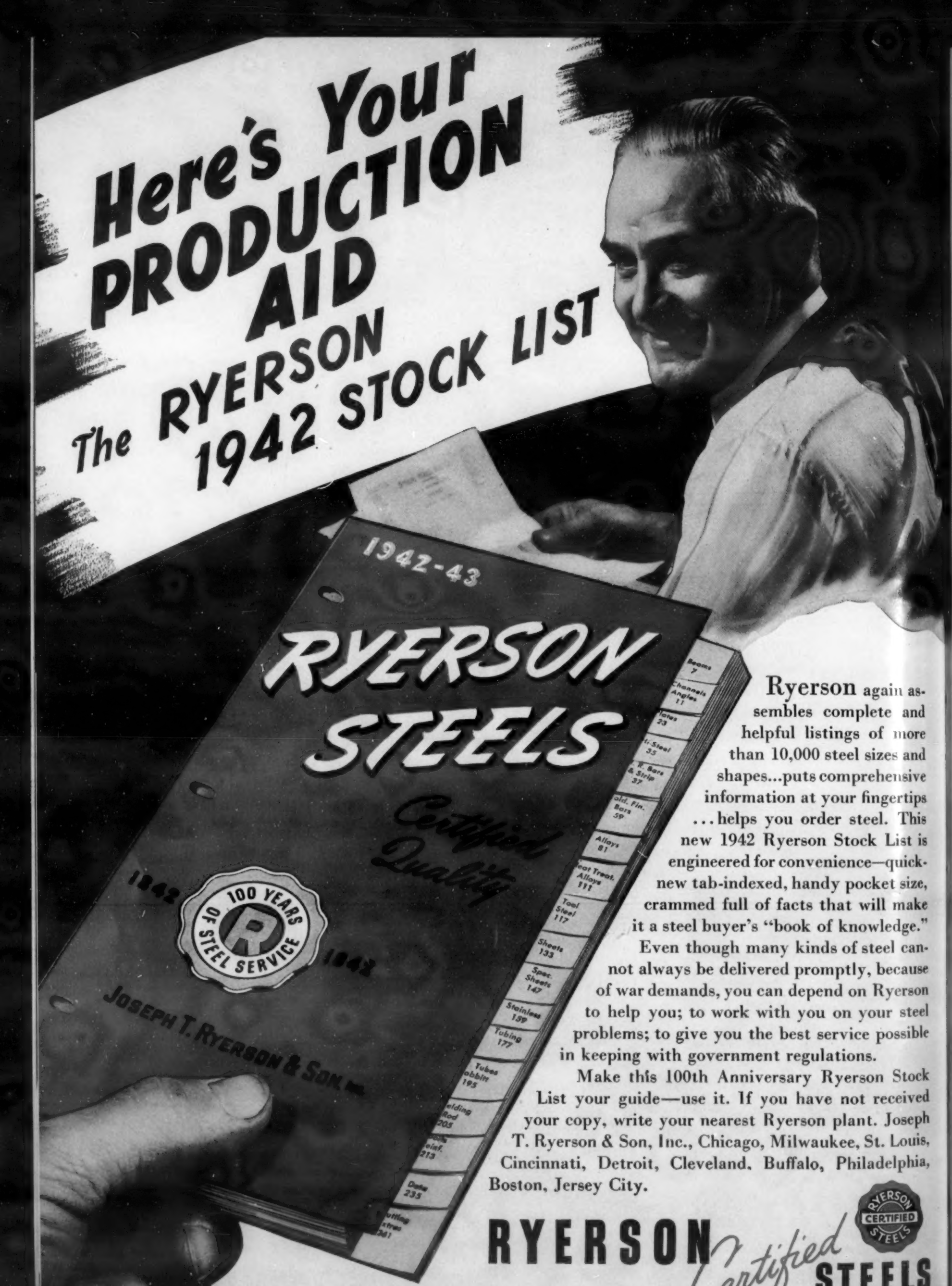
The RYERSON 1942 STOCK LIST



Ryerson again assembles complete and helpful listings of more than 10,000 steel sizes and shapes...puts comprehensive information at your fingertips ...helps you order steel. This new 1942 Ryerson Stock List is engineered for convenience—quick-new tab-indexed, handy pocket size, crammed full of facts that will make it a steel buyer's "book of knowledge."

Even though many kinds of steel cannot always be delivered promptly, because of war demands, you can depend on Ryerson to help you; to work with you on your steel problems; to give you the best service possible in keeping with government regulations.

Make this 100th Anniversary Ryerson Stock List your guide—use it. If you have not received your copy, write your nearest Ryerson plant. Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Philadelphia, Boston, Jersey City.

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bor!" becomes also a grim reminder of human faltering, with a persistent and practical lesson for everyone—engineer or general—who has to work with others.

There are little "Pearl Harbors" (in this sense) all around and among us. On a smaller scale we duplicate the errors of that bastion every time we cling to a pet operating or technical practice just because we've "always done it that way" and even though folks with better or more recent information than ours may politely keep urging us to recognize changed conditions. Or when our brand new heat-treating furnace—for which we and several thousand aircraft engine parts have been waiting since last October—is finally delivered, we painfully remember Pearl Harbor on discovering that none of us had bothered to find out who was ordering the pyrometers, which unhappily are therefore absent. And we need to have someone roar "Remember Pearl Harbor!" at us one hundred times for each instance we arbitrarily decline to accept the observation or consider the opinion of someone just because we may consider him to be less experienced in the matter than we.

Our job now is to produce as much material and as many munitions and machines as we can, and as fast as we can. "Remember Pearl Harbor!" can be a powerful factor in our success even if it does no more than remind us that poor cooperation, taking-things-for-granted, and an aversion to advice can cripple not only vital military defense plans, but essential engineering and production projects as well.

—F. P. P.

Facing the Post-War Period

Right now our primary job is to win the war. When that is done, however long it takes, adjusting ourselves to peace will loom almost as huge and formidable as the task of winning the war. It is essential, therefore, that some of our energies be turned to a consideration of the post-war period.

There are many reasons why the engineer should think of the future that will follow the war. The chief one is that society has come to depend on the engineering profession to an increasing extent for advice and aid in solving the economic and sociologic problems as well as the technical ones.

So, the engineer who early in his evolution was regarded as a strictly theoretical man without a "head" for social planning, has in recent years experienced a broad "humanizing" development. This has made him better able to face social, economic and political problems and to apply his scientific methods to their solution. Of course there are still many engineers who are unable to apply their capacity for logical reasoning outside of their own engineering fields; but their number is diminishing as the profession assumes more and more responsibilities of a sociological nature.

Since the engineer has a profound responsibility in the world of tomorrow, it is encouraging to learn that some members of the engineering profession are giving serious thought to this post-war period. During the past six months the first pioneering steps have been taken by several professional organizations toward the development of a definite plan to cope with the war aftermath.

Several months ago, the Detroit section, American Society of Mechanical Engineers, stimulated by its chairman, A. M. Selvey, appointed a committee of capable, well-known Detroit engineers to explore the post-war future, and from their investigation put forth some initial recommendations as to procedure.

In October, last year, David C. Prince of the American Institute of Electrical Engineers, outlined the same problems and suggested in part some solutions before a joint conference of secretaries and presidents of the Founder Engineering Societies. As a result a joint committee of the four societies has been formed with the purpose of determining in what ways the engineering societies can be most helpful.

The task which these groups have tackled is

(Continued on page 426)

The Ford Magnesium Alloy Foundry

by EDWIN F. CONE

One of the steps in the melting and pouring operation.

Mounting aircraft production requirements have transformed the magnesium alloy foundry from a glamorous but small-volume unit to an expanding and vitally important part of our all-out war effort. This article describes the Ford Motor Co.'s new foundry for making magnesium alloy aircraft castings, and the up-to-date melting, casting and heat treating practices employed.—The Editors.

Another view of the pouring of the molten magnesium alloy, just previous to transferring it to the molds.

IN CARRYING OUT ITS PLAN of full cooperation with the National Government and the Victory Program, it has been necessary for the Ford Motor Co. to build and operate its own foundry for making magnesium alloy castings. It has very large orders for airplane engines for a leading aviation company and these engines require substantial quantities of these alloy castings.

When the orders for these engines were taken, the Ford company realized that the magnesium foundry facilities of the country were far below the needs of the present Government program. Hence the new Ford foundry.

This new foundry is one of the few in this country. The production of magnesium alloy castings is a comparatively young industry. Construction was started late in December 1940, and this magnesium unit, which has been incorporated in the south end of the existing foundry building of the Ford plant at Dearborn, Mich., is now in production. It has several interesting and unique features, both as to metallurgical and foundry practice. It is the object of this article to point out the highlights.

All the foundry operations are conducted on two floors, embracing about 100,000 sq. ft. On the first or lower floor are the loading and unloading end of the heat-treating furnaces, the castings impregnating apparatus, core-making equipment, the pickling apparatus, the inspection department, the office and the laboratory. On the second floor are the melting department, the molding, and other minor departments.

The Alloy Used

At present all the castings being produced are made of one alloy, known familiarly as S.A.E. No. 50 or Dow H. Its composition is:

	Per Cent
Aluminum	6.00
Zinc	3.00
Manganese	0.20
Magnesium	Bal.

This alloy is furnished in pigs by the Dow Chemical Co., Midland, Mich. Other alloys may be used later and it is possible that Ford may eventually produce his own alloys.

To melt and prepare this alloy in the best possible condition for pouring into molds, there are 17 gas-fired crucible furnaces ranging in capacity from 2,000 lbs. down to 100 lbs. each. There are four 2,000-lb. units, two of 400 lbs., seven of 200 lbs. and four of 100-lb. capacity, all fired with coke-oven gas from the Ford coke ovens.

The Melting Practice

The alloy is melted first in one of the 2,000-lb. furnaces, the charge consisting on the average of 30 per cent virgin alloy and 70 per cent return scrap—heads and gates. It takes about 2 hrs. to melt this charge and bring it to about 1,250 deg. F. The alloy's melting point is 1,130 deg. F. Portions of this melted charge are transferred to smaller crucible furnaces, usually the 200-lb. type, and superheated to about 1,600 deg. F. When this temperature has been reached the crucibles, used as ladles, are transferred by overhead conveyors to the molds and the alloy is poured at around 1,420 to 1,520 deg. F. The furnaces each have their own recording pyrometer control. An indicating pyrometer shows the temperature just before pouring.

Because of the fire hazard in handling molten magnesium, a special flux is used in melting—a standard magnesium chloride base flux—in the large crucibles and a dry flux of the same general character in the smaller units. This protects the magnesium and acts similarly to a slag. The major portion of the flux is skimmed off after the melting cycle is completed and before pouring. To still further protect the molten metal while pouring, the surface of the metal is dusted with a mixture of powdered sulphur and boric acid. The SO_2 generated shields the hot metal from

A section of the core making department. Core-blowing machine in center. Vertical core ovens in background.

Down these chutes comes the core sand for the use of the core-makers in one section of the core-making department. Different types of core sands may be delivered into chutes by a system of plows.

the oxygen of the air and the boric acid takes care of the moisture that may be present.

The smaller crucibles are made of about ¼-in. low carbon steel plate, formed to make the body of the crucible, and welded. A bottom of the same material is welded on. The average life of these is about 350 heats. The outside surface is protected from excessive scaling by spraying with metallic aluminum to further increase their life. All the 2,000-lb. crucibles are of cast steel and thus far none has failed. It is stated that the use of coke-oven gas as a fuel insures longer life.

Molding Practice

Some general facts about the molding sand and cores are of interest. All castings are poured in green sand molds. A silica washed sand (99%+SiO_2) is used to which is added Bentonite. There is also

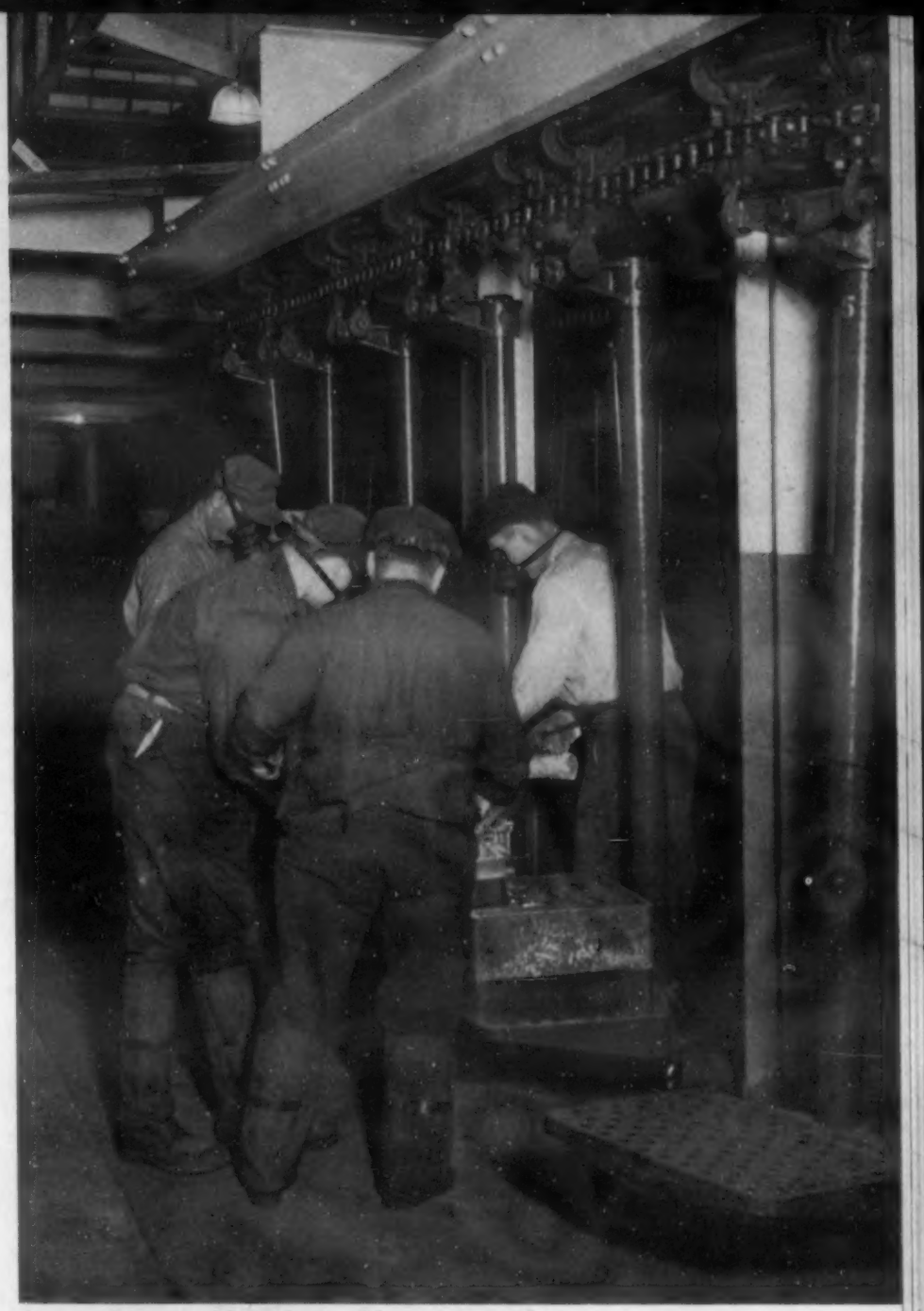
mixed with these ingredients about 2 per cent sulphur and 2 per cent boric acid by weight as well as 1 per cent diethylene glycol which tends to keep the sand from drying. Sand slingers are used for ramming.

The sand for cores is similarly prepared, with the addition of sulphur and boric acid, though less sulphur is added— about ½ to ¾ per cent. Cores are all thoroughly baked in continuous coke oven gas-fired ovens. This addition of sulphur and boric acid is the result of development work in various European countries. These ingredients perform the same functions as indicated from their use in the pouring operations—they protect the magnesium from burning by forming a suitable atmosphere.

It is a rather interesting fact that, as the old or "burnt" sand is used over and over, it seems to become progressively better.

Handling the Cores

A peculiarity of the cores is that they are hard and tough after the castings are shaken out and very difficult to remove. This is due to the fact that the specific heat of the alloy is very low and the metal cannot burn out the core binders completely. A hydroblast machine has been installed which quickly and thoroughly removes these cores. In a special chamber, water under high pressure carrying sand is turned on the castings and the cores are rapidly removed. Cores which require ordinarily several hours



Conveyors on which the molds are poured.

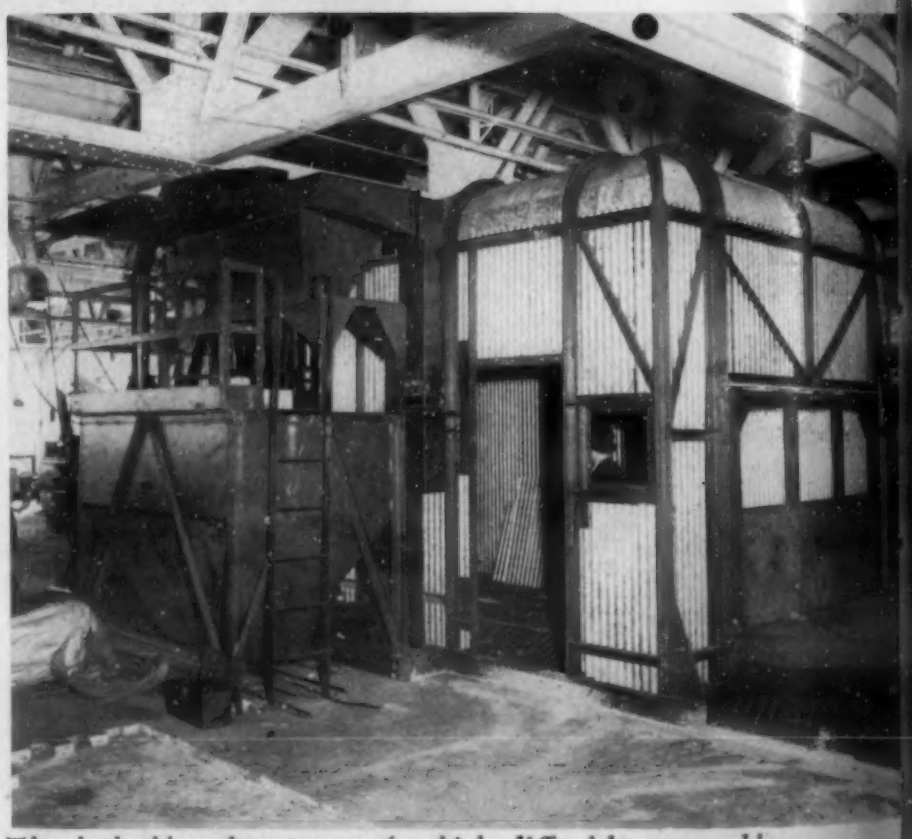
One section of the cleaning department. At the right on a table can be seen the extent to which risers must be used.

One of the special cleaning or chipping booths down which a blast of air forces highly inflammable magnesium dust and chips into water underneath.

for removal by conventional foundry cleaning methods are disposed of in this equipment in only a few minutes. This is said to be the first magnesium foundry to install a hydroblast for this purpose.

In certain cases, depending on the use to which the castings are to be put, it is necessary to be sure that they are watertight. An impregnating machine is available for this. China wood oil is injected into such castings under pressure. They are then baked which polymerizes the oil and fills up porous parts.

Another novel equipment is a set of cleaning booths. Because of the fire hazard from fine dust or chips of the metal, castings are cleaned in a booth down which an airblast rushes conveying the fine metal into water underneath. Sludge is piped to a settling tank located on the floor below. In fact all through the foundry operations in making these high magnesium alloys, fire hazard and precautions relating thereto are prime considerations. A special apparatus is available to throw a stream of fine sand on a fire caused by magnesium and smother it completely.



The hydroblast by means of which difficultly removable cores are easily washed out by a stream of water and sand.

Heat Treating Practice

Of outstanding importance is the heat treating of magnesium alloys, and this has been adequately provided for in this foundry. Two vertical batch heat-treating furnaces have been erected, heated by electricity. They extend up from the first floor through the second. The loading and unloading is done on the first floor or at the bottom of the furnaces. Castings are put on racks or conveyors which are then elevated into the heated chambers. Air is blown through the heating elements into the chambers to insure even and thorough heat distribution.

For solution treatment the castings are held in the furnaces for 12 hrs. at 715 to 730 deg. F. and then air cooled under forced draft in the furnace. This is followed by aging to obtain certain properties, that is, heating at 350 deg. F. for 16 hrs. or more and similarly cooled. These treatments bring out the best properties for the only alloy now being used, S.A.E. No. 50 or Dowmetal H. The physical properties

Putting out a fire by a blast of sand is the most effective way. Some castings with numerous heads and gates stand on the table.

after these important treatments are as follows:

	As Cast	Heat Treated	Heat Treated and Aged
Tensile strength lbs. per sq. in.	27,000	36,000	40,000
Yield strength lbs. per sq. in.	12,000	16,000	22,000
Elong. in 2 in. per cent	5.0	9.0	1.0
Brinell Hardness No.	50	58	65

For alloys of different compositions, the heat-treating cycle will vary.

Solved and Unsolved Problems

There are many problems yet to be solved in this new foundry venture. Some already have been. For example, it has been a fixed belief that molds for magnesium alloys cannot be poured except on a firm fixed foundation, one not subject to any jarring. It has already been demonstrated by extensive Ford experiments that these molds can be poured with no detrimental effect, even on a vibrating machine. The present practice is to pour the molds as they travel on a conveyor system.

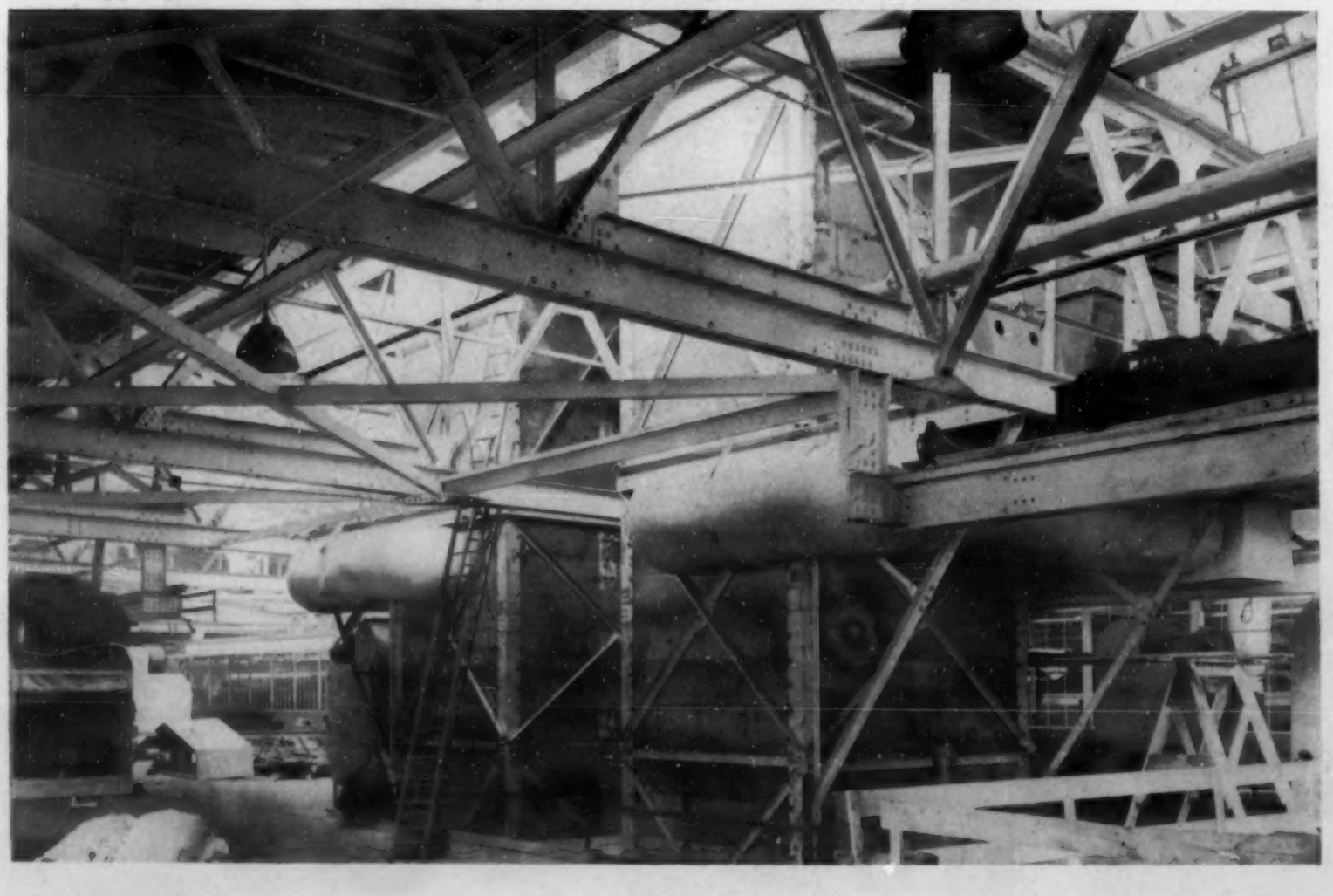
Another interesting fact is that, because of the rather excessive shrinkage of the alloy, there must be provision made for sufficient sinkheads and gates. The average casting requires heads and gates in the proportion of 3 to 1, that is, for a casting weighing 100 lbs. about 250 to 300 lbs. of return scrap are involved. In other words the yield of metal in the finished casting is usually about 25 per cent, or to pour a 100-lb. casting about 400 lbs. of metal are necessary. This corresponds to an average of 40 to 50 per cent for aluminum alloy and to about 66 per cent for steel castings. However, by the use of central risers feeding several sections, the yield has been increased from 25 to 33 per cent in some cases. Risers of this type are removed by a machining operation.

In general the weight advantage in using magnesium metal instead of iron or aluminum for large castings and other aircraft parts is a vital factor in airplane engine performance. Pound for pound magnesium is virtually as strong as the average cast iron and one advantage in its use is its high strength with low weight. The alloy is about one-fourth the weight of cast iron and approximately two-thirds that of aluminum alloys.

On a 16-hr. working basis the capacity of this new foundry is about 137,000 lbs. of castings a month on a 20 hr. per day basis. New equipment is now being installed to increase capacity to 249,000 lbs. per month. All of these go to the new Ford aircraft engine plant recently built at a cost of about $25,000,000 for use in making the Pratt & Whitney engines.

As our aircraft program develops it is probable that magnesium will gradually play a still more vital and essential role than at present. This phase of the American non-ferrous foundry industry certainly has a bright future.

Upper portion of the heat-treating furnaces extending up through the second floor and to the roof.



Reference Table of

ALTERNATES AND SUBSTITUTES

Compiled by H. R. Clauser

Substitutes and alternates in the automotive industry continue to be an important and engrossing matter. Although no more automobiles for non-essential civilian use are being manufactured, essential motor vehicles of all kinds—trucks, "jeeps," tractors, tanks, etc.—are still being produced. This table should be of interest not only to the metallurgical engineer in the automotive field, but also to those in other industries who have similar substitution problems.

In the table, the numbers given for the alloy steels are the SAE specification numbers. Additional information on alternates for these and many other alloy steels will be found in the reference table (Section 2a) on the following page.

SECTION 2—MOTOR VEHICLES—MILITARY, TRANSPORT, etc.

Scarce Material or Method		Part	Substitute Material
Aluminum Alloys		Distributor body	Iron castings
		Engine front-end oil seal	Plastics
		Directional switch housing on steering gear	Iron castings
		Rocker-shaft bracket	Malleable iron castings
		Valve chamber cover	Iron castings
		Engine pistons	Pearlitic malleable iron, steel, and iron castings
		Brake wheel piston	Low-grade aluminum castings; iron powder parts, plated
		Cylinder head	Iron castings
		Oil cleaner cover	Steel stampings
		Timing gears	Plastics with steel center
Aluminum Sheet		Horn resonator disc	Sheet steel
Antimonial Lead		Storage battery grids	Calcium-lead; silver
Brass		Radiator tubes and tanks	Surface treated steel; terne-plated steel
		Brake cylinder piston	Tin-plated screw-machine steel
		Automatic clutch valve	Iron castings
Bronze		Bearings, bushings	Iron powder parts
Chromium-Tungsten Steel		Valve seat inserts	Chromium-molybdenum steel
Copper-Asbestos		Gaskets	Steel-asbestos
Molybdenum-Nickel Steel (4615A)		Differential pinion spiders	Molybdenum-chromium steel (4115)
Nickel-Chromium Steels	Ni-Cr steel	Fuel pump arm	Chromium-molybdenum steel
	3115A	Steering arm ball studs	Chromium-molybdenum steel (4115)
	3115A	Universal joint yoke trunnions	Chromium-molybdenum steel (4115)
	3115A	Differential pinion shaft	Chromium-molybdenum steel (4115)
	3115A	Front axle kingpins	Chromium-molybdenum steel (4115)
	3135A	Differential lock screws	Chromium-molybdenum steel (4140)
	3140A	Axle-shaft bolts	Chromium-molybdenum steel (4140)
	3140A	Inlet valves	Chromium-molybdenum steel (4140)
	3135A	Steering knuckles	Chromium-molybdenum steel (4140)
	3045A X-3140A	Steering knuckle support	Chromium-molybdenum steel (4140)
	X-3150A	Axle shafts, final drive gears	Chromium-molybdenum steel (4150)
	3135A	Pitman arm studs	Manganese steel (1340); molybdenum steel (4140)
Nickel-Chromium Steels	1½-12% Ni	Exhaust valves	Chromium-silicon steel (7-18% Cr, 2-3½% Si)
	3135A	Propeller shaft couplings	Chromium steel (5145)
	3130A	Differential side gears	Chromium steel (5130)
Nickel-Molybdenum Steels	4615	Rear axle ring gear	Chromium steel (5120)
	4600	Rear axle gearing	High manganese steel (1320)
Silver-plated Brass		Reflectors (lamp)	Glass
Steel, Carbon		Body parts	Plastic panels; soybean fiber
Steel Forgings		Front suspension arms	Steel stampings
Tin-Base Babbitts		Bearings, bushings	Lead-base babbitts; indium-plated cadmium-silver-copper
Tin Coatings		Engine pistons	Phosphate coating
Tin Solders		Radiator solders	Lead-silver, cadmium-silver, lead-cadmium solders
Terneplate		Mufflers	Carbon steel
Zinc Alloy Die Castings		Door lower channel roller assembly	Steel stamping
		Speedometer pinion sleeve	Iron castings
		Clutch torque shift pivot bearing	Plastics
		Fuel pumps	Iron castings; plastics
		Carburetors	Iron castings; plastics
		Transmission cover	Iron castings
		Speedometer gears	Plastics; steels
		Shift control arm	Steel forgings
		Defroster funnel	Steel stampings
		Lock switch housing	Iron castings; antimonial lead die castings
		Shock absorber guides	Iron castings
		Radiator grilles	Steel stampings; lead-antimonial die castings
		Instrument panel grille	Plastics; steel stampings
		Steering wheel hub and brackets	Steel stampings; malleable iron castings
		Horn ring	Stamped steel-plated, welded
		Number-plate bracket	Cold-rolled steel
		Tail-light housing	Molded glass, silver-plated

SECTION 2a—ALTERNATES FOR ENGINEERING AND MACHINERY STEELS

The Alternate Steels—Designations and Compositions

Alloy Type	Designation Number	Composition, per cent				
		Carbon	Manganese	Molybdenum	Nickel	Chromium
Carbon-Molybdenum	A 4027	0.25/0.30	0.70/0.90	0.20/0.30	———	———
	A 4037	0.35/0.40	0.75/1.00	0.20/0.30	———	———
	A 4047	0.45/0.50	0.75/1.00	0.20/0.30	———	———
	A 4063	0.60/0.67	0.75/1.00	0.20/0.30	———	———
	A 4068	0.64/0.72	0.75/1.00	0.20/0.30	———	———
Low Chromium-Molybdenum	A 4125	0.23/0.28	0.70/0.90	0.20/0.30	———	0.40/0.60
Manganese-Molybdenum	NE 8024	0.22/0.28	1.00/1.30	0.10/0.20	———	———
	NE 8124	0.22/0.28	1.30/1.60	0.25/0.35	———	———
	NE 8233	0.30/0.36	1.30/1.60	0.10/0.20	———	———
	NE 8245	0.42/0.49	1.30/1.60	0.10/0.20	———	———
	NE 8339	0.35/0.42	1.30/1.60	0.20/0.30	———	———
	NE 8442	0.38/0.45	1.30/1.60	0.30/0.40	———	———
	NE 8447	0.43/0.50	1.30/1.60	0.30/0.40	———	———
	NE 8547	0.43/0.50	1.30/1.60	0.40/0.60	———	———
Low Nickel-Chromium-Molybdenum	NE 8620	0.18/0.23	0.70/0.95	0.15/0.25	0.40/0.60	0.40/0.60
	NE 8630	0.27/0.33	0.70/0.95	0.15/0.25	0.40/0.60	0.40/0.60
	NE 8724	0.22/0.28	0.70/0.95	0.20/0.30	0.40/0.60	0.40/0.60
	NE 8739	0.35/0.42	0.75/1.00	0.20/0.30	0.40/0.60	0.40/0.60
	NE 8744	0.40/0.47	0.75/1.00	0.20/0.30	0.40/0.60	0.40/0.60
	NE 8749	0.45/0.52	0.75/1.00	0.20/0.30	0.40/0.60	0.40/0.60
	NE 8817	0.15/0.20	0.70/0.95	0.30/0.40	0.40/0.60	0.40/0.60
	NE 8949	0.45/0.52	1.00/1.30	0.30/0.40	0.40/0.60	0.40/0.60

The American Iron & Steel Institute last month issued a 144-page booklet, "Possible Alternates for Nickel, Chromium and Chromium-Nickel Constructional Alloy Steels", prepared by metallurgical engineers of the S.A.E. and the A.I.S.I. In this are presented 16 new "National Emergency" steels (NE steels) of low alloy content, together with 6 already-standardized A.I.S.I. steels—each of which, on the basis of hardenability values and heat treating behavior reported in the pamphlet, can satisfactorily be substituted for one or more specific S.A.E. (or analogous A.I.S.I.) steels of higher critical alloy content.

The reference tables on this page present, in conveniently assembled and condensed form, (1) the composition of the 22 "possible alternate" steels in these 4 groups, and (2) representative commonly-used higher-alloy steels for which they might be substituted, and some typical applications involved. These tables are published by us as a supplement to the table of alternates in motor vehicle products that appears on the preceding page, because the steels in question are characteristically "automotive" steels, although they are widely used, of course, in countless other industries as well.

—F.P.P.

How the Alternate Steels Can Replace Standard, Higher-Alloy Steels

General Grades	Steels Commonly Used		Alternate Steels	Typical Uses for Which Substitution is Possible
	A.I.S.I. No.	Alloy		
Carburizing Steels	A 1320	1.75 Mn	A 4027	automotive differential ring gears and pinions
	A 2317	3.5 Ni	A 4027, A 4125, NE 8620	auto gears, knuckle pins, shafts and collars
	A 2515	5 Ni	A 4027, NE 8817	aero engine crankshafts, truck and tractor gears
	A 3120	1.25 Ni, 0.65 Cr	A 4027, A 4125, NE 8620	tractor transmission gears, anti-friction bearings
	A 4120	0.7 Cr, 0.25 Mo	A 4027, A 4125	differential ring and pinion gears, tractor gears
	A 4320	1.8 Ni, 0.5 Cr, 0.25 Mo	NE 8724	truck transmission and differential gears
	A 4620	1.8 Ni, 0.25 Mo	A 4027, A 4125, NE 8620	transmission and differential gears, pins, shafts
	A 4820	3.5 Ni, 0.25 Mo	NE 8724	heavy transmission and differential gears and shafts
	A 5120	0.80 Cr	A 4027, A 4125	tractor gears and pinions, pins and shafts
	A 6120	0.80 Cr, 0.1 V	A 4027, A 4125, NE 8620	truck differential gears, shafts and pins
Medium-Hardening (lower-carbon) Steels	A 1330	1.75 Mn	A 4037, NE 8233	axle shafts and shackle bolts
	A 2330	3.5 Ni	A 4037, NE 8233, NE 8630	aircraft bolts, gun and tank parts
	A 3130	1.25 Ni, 0.65 Cr	A 4037, NE 8233, NE 8630	axles, drive shafts and stressed bolts, studs, nuts
	A 4130	1 Cr, 0.2 Mo	A 4037, NE 8233, NE 8630	aircraft tubing, sheets and bars; bolts
	A 5130	1 Cr	A 4037, NE 8233	automotive side gears
	S.A.E. 6130	1 Cr, 0.15 V	A 4037, NE 8233, NE 8630	aircraft propeller blade
High-Hardening (high-carbon) Steels	A 1340	1.75 Mn	A 4047, NE 8245	transmission gears, spline shafts, knuckles
	A 2340	3.5 Ni	A 4068, NE 8442, NE 8744	aircraft engine connecting rods, rocker arms, gears
	A 3045	0.70 Ni, 0.70 Cr	A 4068, NE 8442, NE 8744	automotive steering arms, knuckle supports
	A 3140	1.25 Ni, 0.65 Cr	A 4068, NE 8442, NE 8744	crankshafts, connecting rods, gears
	A 3240	1.8 Ni, 1 Cr	A 4068, NE 8442, NE 8744	drive and axle shafts and transmission gears
	A 4137	1 Cr, 0.2 Mo	A 4063, NE 8339, NE 8739	aircraft propeller blades, cylinder liners, crankshafts and tubing; automotive connecting rods
	A 4340	1.8 Ni, 0.8 Cr, 0.25 Mo	A 4068, NE 8547, NE 8949	aircraft engine parts; automotive crankshafts
	A 4640	1.8 Ni, 0.25 Mo	A 4063, NE 8339, NE 8739	aircraft engine forgings; auto and tractor gears
	A 5045	0.65 Cr	A 4063, NE 8339	clutch shafts and transmission main shafts
	A 5150	0.8 Cr	A 4068, NE 8447	leaf and coil springs, steering worms, gears
	A 6150	1 Cr, 0.15 V	A 4068, NE 8447, NE 8749	aero engine parts; auto pinion gears and springs
	A 9260	2 Si, 0.8 Mn	A 4068	auto, tractor and R.R. leaf and coil springs; tools

Brake Drums—II

By OLIVER SMALLEY

President, Meehanite Metal Corp., Pittsburgh

The first part of this article, published in February, discussed brake drum materials in general and their service requirements. The actual results of performance tests on 4 types of brake drum irons—with and without alloy—are given in the present instalment.—The Editors.

Four Drum Materials Tested

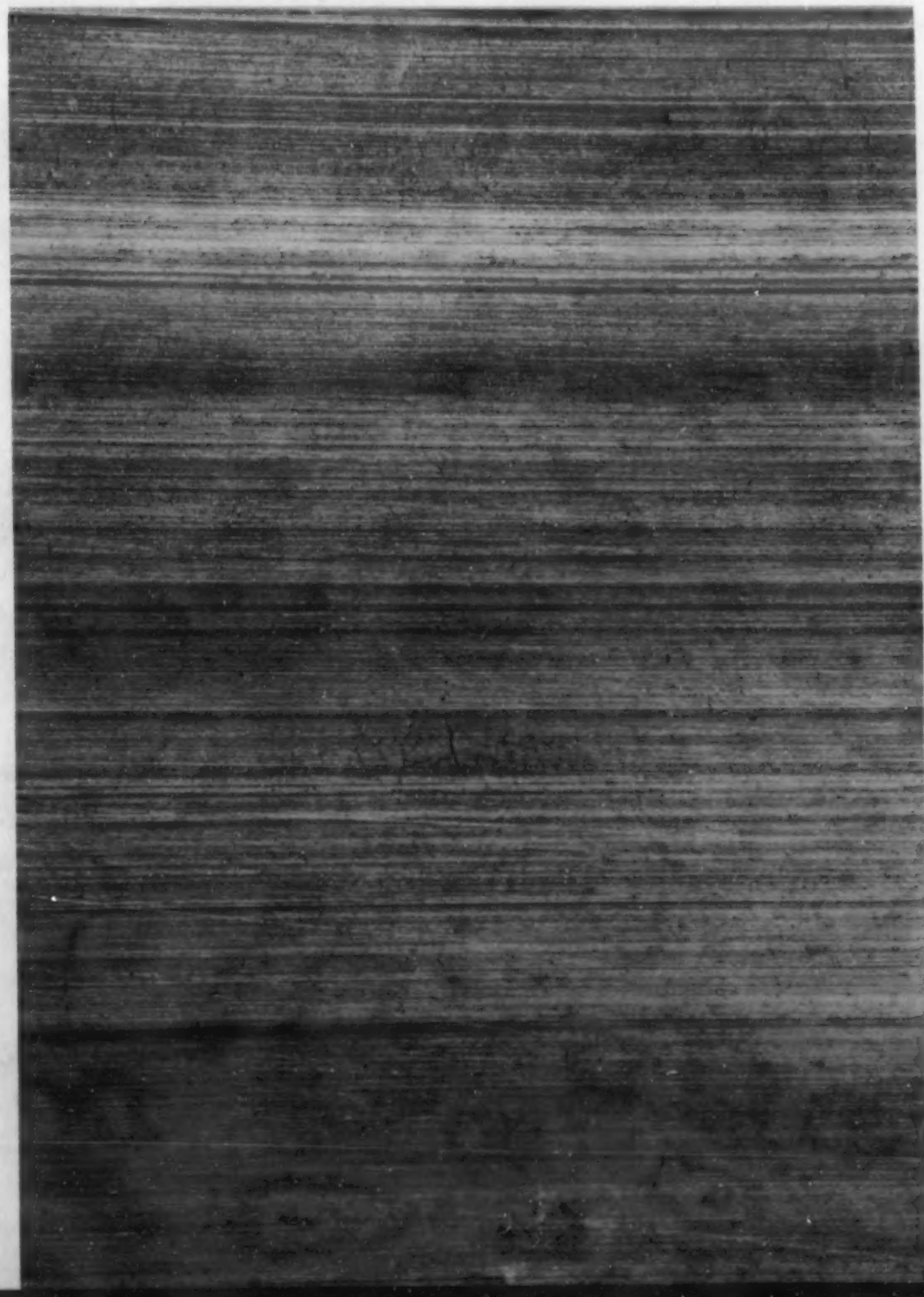
For the purpose of this article four types of drum materials will be considered:

1. A standard "GD" Meehanite.
2. A molybdenum cast iron.
3. A high test cast iron.
4. A nickel-chromium cast iron.

Test No. 1—Type "GD" Meehanite

Fig. 15 represents the surface of the drum that gave the best results in the thermal check test. Photomicrographs, Figs. 16 and 17, were taken from a longitudinal section cut through the face of the drum and were mounted in bakelite so that it would be possible to get a clear-cut picture of the surface right up to the

Fig. 15. Appearance of the drum surface of the Type GD Meehanite iron after the test. 2X. The surface is shown to be lightly scored and thermal checks are just beginning to form.



edge of the worn surface.

Photomicrograph, Fig. 17, shows how the cracks progress along the graphite flakes and how the graphite is enlarged, particularly at the outer 0.005 in. Some deterioration is also exposed about 0.02 in. back from the surface where it would appear that the matrix was beginning to reach its limit in resisting the severe opposing stresses set up in service. The interior structure of this drum is revealed by photomicrographs Fig. 18 and Fig. 19 at 100 and 500 times respectively. These reveal that this drum material displays no free ferrite, only traces of phosphide, whilst the pearlite is of an exceedingly fine nature bordering onto sorbite.

All Meehanite type "GD" brake drums are made precisely to this structure, and this explains their uniformity of properties and long service life. It is, of course, old knowledge that thermal checking of not only brake drums but of any part subjected to rigid heating and cooling bears direct relation to the quantity and form of the graphite, graphitic irons in general being superior to those of lesser graphite content.

The explanation of this is found in the graphite flakes permitting the casting to breathe, as it were, under conditions of opposing stresses. A dense iron of low graphite content does not accommodate itself to a severe reversal of stresses, and the casting cracks prematurely.

Unfortunately, where both wear and thermal stresses are encountered at the same time as in a brake drum, the graphite content is strictly limited. Various attempts have been made by brake drum manufacturers to produce a high graphitic content introducing alloys to stiffen up the matrix and so confer, in addition to good thermal check properties, improved wear resistance.

In this regard molybdenum and nickel are useful materials, while the judicious use of chromium in combination with either or both is sometimes helpful. In order to compare such an iron with the preceding test, a series of drums were cast and tested under similar conditions.

Brake Drum Test No. 2

The analysis of these drums was as follows:

	Per Cent
Total carbon	3.48
Silicon	1.89
Manganese	0.94
Phosphorus	0.17
Sulphur	0.104
Molybdenum	0.75

The Brinell hardness of the actual drums ranged between 207 to 219.

Photomicrographs Figs. 20 and 21 reveal a generous quantity of well distributed graphite, patches of

Fig. 16. Structure of the graphite of Meehanite "GD" iron before the test. 100X.

Fig. 17. Structure of the same iron as Fig. 16, after the test. 100X.

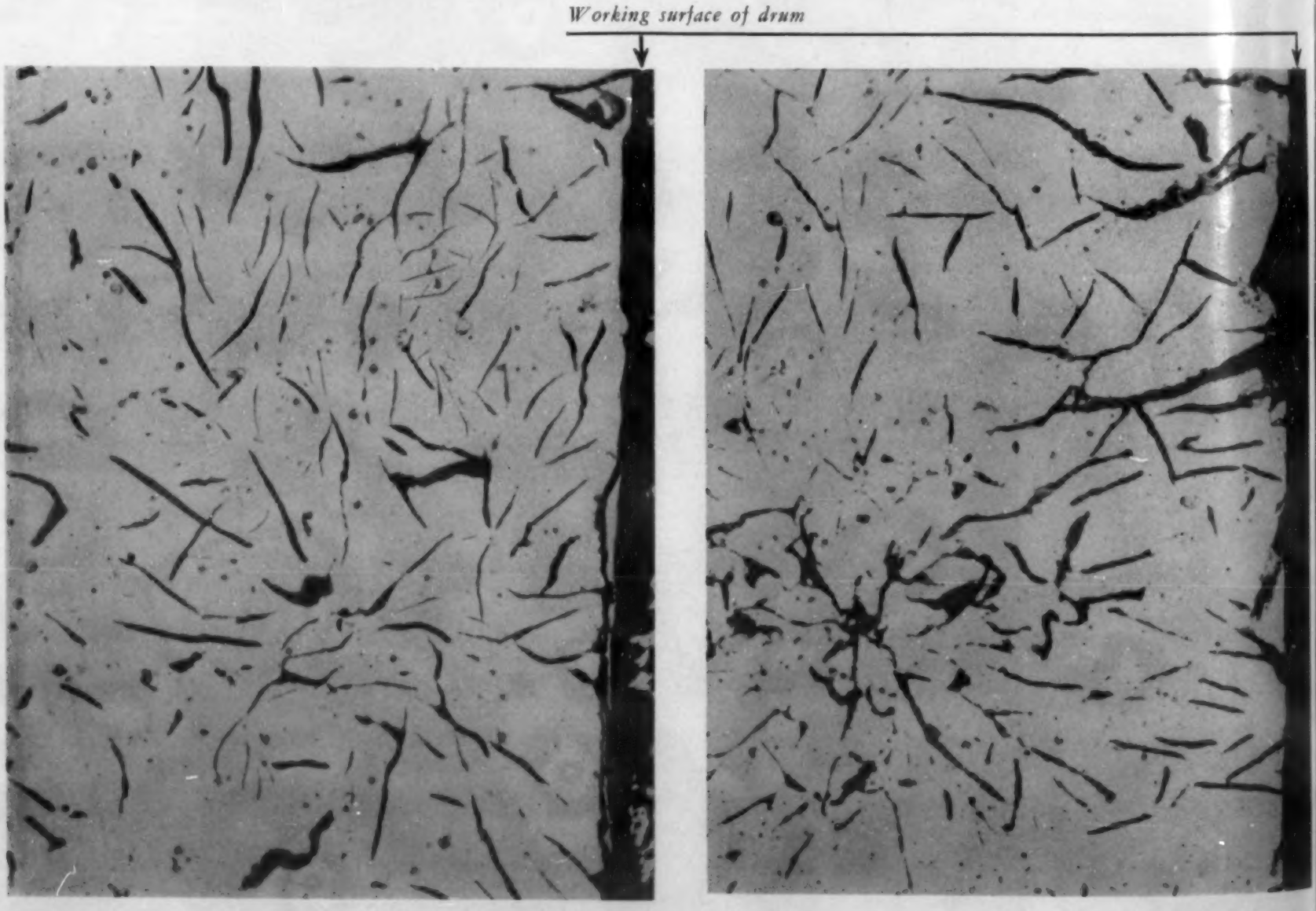


Fig. 18. Interior structure of drum of Meehanite iron. 100X.

Fig. 19. Same as Fig. 18. 500X.

Fig. 20. Structure of brake drum test iron No. 2 at 100X.

Fig. 21. Same as Fig. 20 but at 500X.

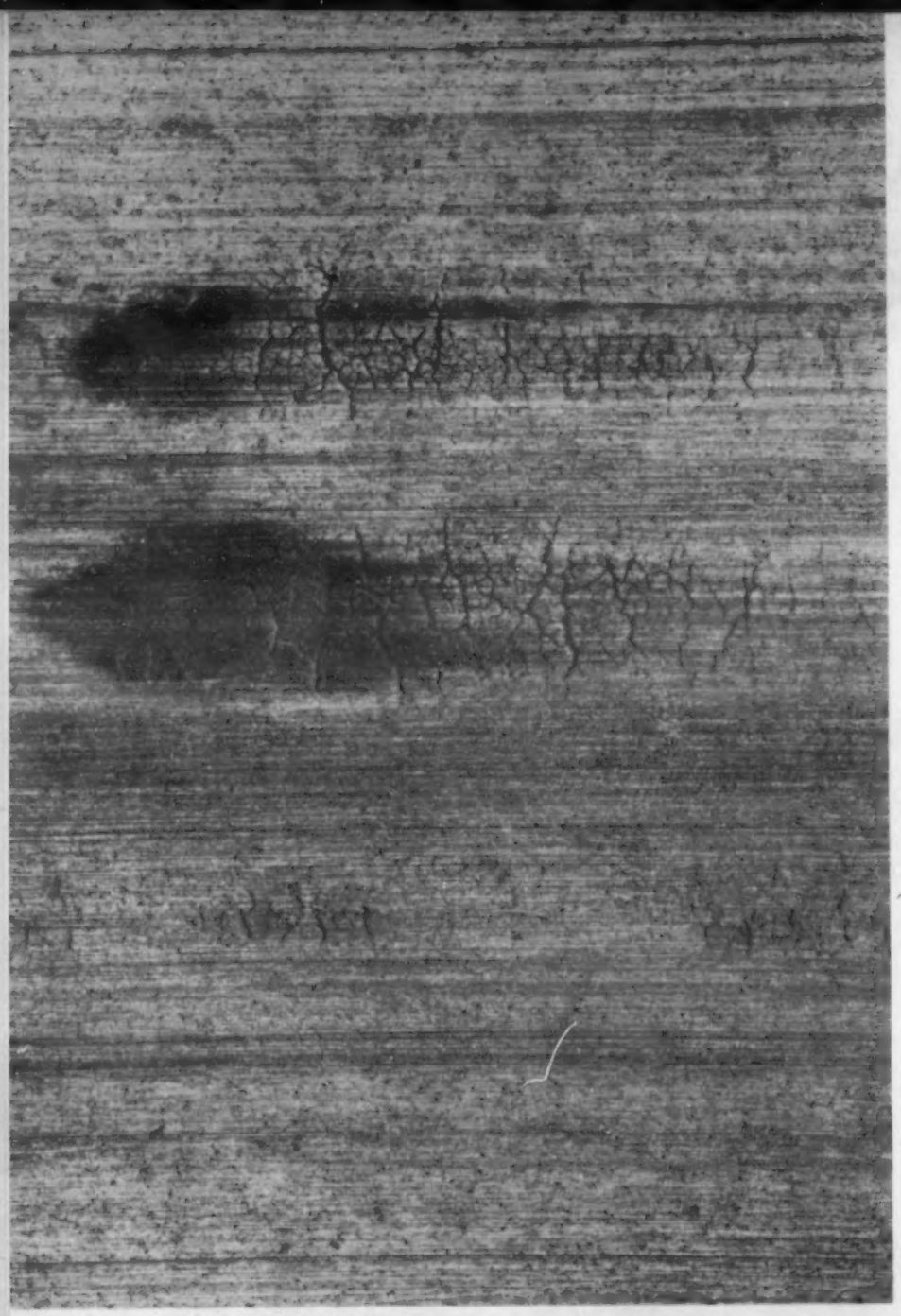


Fig. 22. This reveals the surface of a drum after the finish of the test, indicating quite a marked thermal checking. In fact, this particular kind of drum stood up only fourth but showed up with exceptionally good rating in resisting scoring.

molybdenum ferrite around the graphite flakes, and the remaining material consisting of a fine pearlite. Such a structure should, in the absence of alloys, possess an exceptional resistance to thermal checking but would have a poor scoring value.

The dark smears shown on Fig. 22 appeared in all the drums toward the end of the test. They are not superficial stains but penetrate deep into the cracks. They are oxidized iron, and where present, the surface of the iron and the cracks are actually coated with heavy deposits of magnetic oxides of iron indicating the high degree of temperature to which these drum surfaces are exposed in service.

Photomicrograph, Fig. 23, exhibits a section through the wearing surface at a magnification of 100 times illustrating the form and depth of the thermal cracks, also the coating of oxide along the side of the main crack. Photomicrograph, Fig. 24, shows an etched section through the wearing surface of the

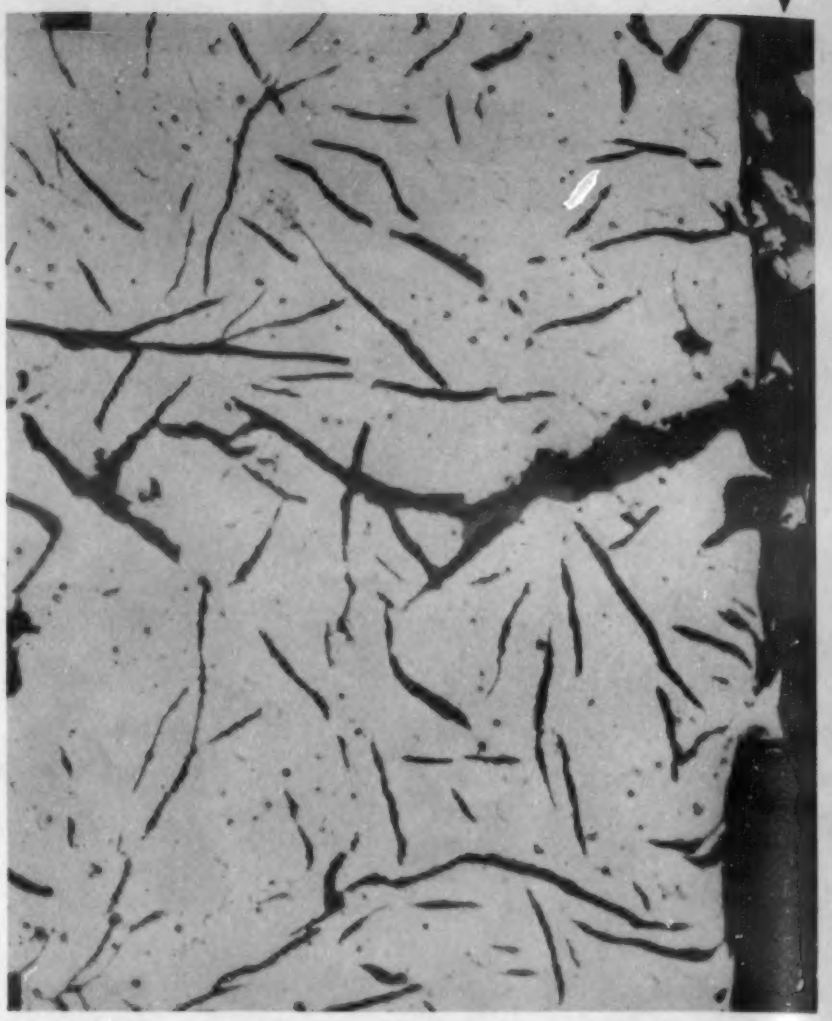


Fig. 23. Graphite structure at face of the drum after the test. 100X.

Fig. 26. Unetched. 100X.

Fig. 24. Etched surface of drum after test. 500X.

Fig. 25. Microstructure of face of drum through thermal crack. 500X.

Fig. 27. Etched. 100X. Same as Fig. 26.

Fig. 28. Same as Fig. 27. 500X.

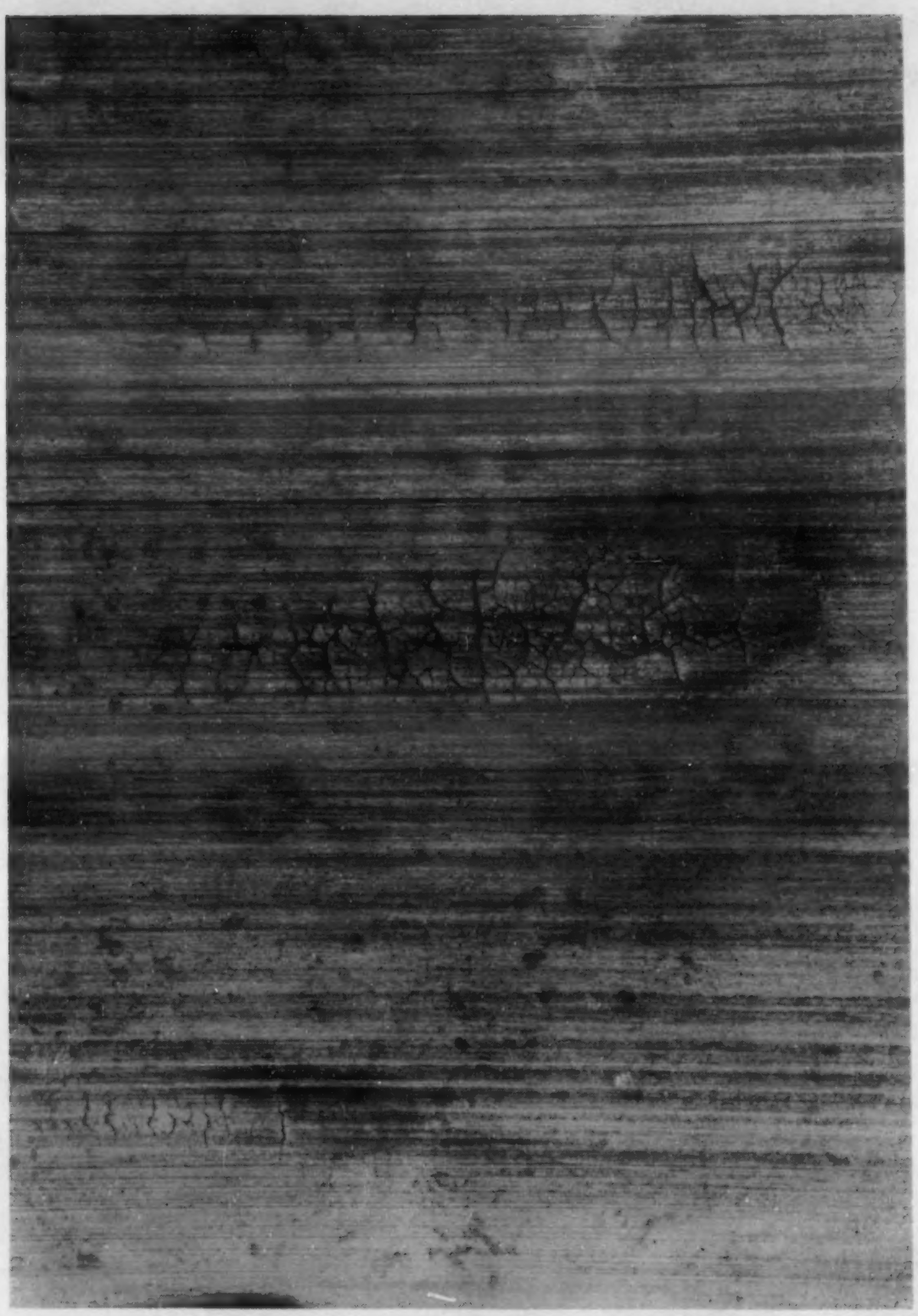


Fig. 29. Actual appearance of a drum iron after dynamometer tests.

cracked drum after thermal testing magnified 500 times. The areas of decarburized iron and the extent that heating has influenced the original structure is apparent. Photomicrograph, Fig. 25, shows the same section magnified 500 times and better reveals the thermal cracks following the flakes of graphite, the extent of decarburization along the cracks, and the heavy deposit of oxide of iron both on the surface of the drum and penetrating into the cracks.

This study would indicate that while large quantities of graphite may help in improving the life of a brake drum against thermal checking, this is only true when the graphite is well distributed and is not in a massive and continuous form.

Brake Drum Test No. 3

For the completion of this study let us now consider a brake drum iron made to the other extreme—with a total carbon of 3 per cent and having tensile properties approaching 40,000 lbs. per sq. in. In practice other than Meehanite, the foundryman compensates for the hardening effect of the reduced total carbon content by the use of silicon.

A series of drums from such an iron were made to the following chemical analysis:

	Per Cent
Total carbon	3.03
Silicon	2.09
Manganese	0.8
Phosphorus	0.104
Sulphur	0.068

This is a good analysis, and the finished drums had a Brinell hardness of 217. The structural form of the graphite in an actual drum is depicted by photomicrographs, Figs. 26, 27 and 28.

The quantity of graphite is shown to be a good deal less than found in the drums of Tests Nos. 1 and 2. The graphite now appears in small thin flakes or small nodules. Such a structure is typical of a dense iron of good tensile properties, and while it may be suitable for brake drums for aircraft service where high strength and shock resisting properties are necessary, it is not recommended for drums that must withstand excessive heat checking.

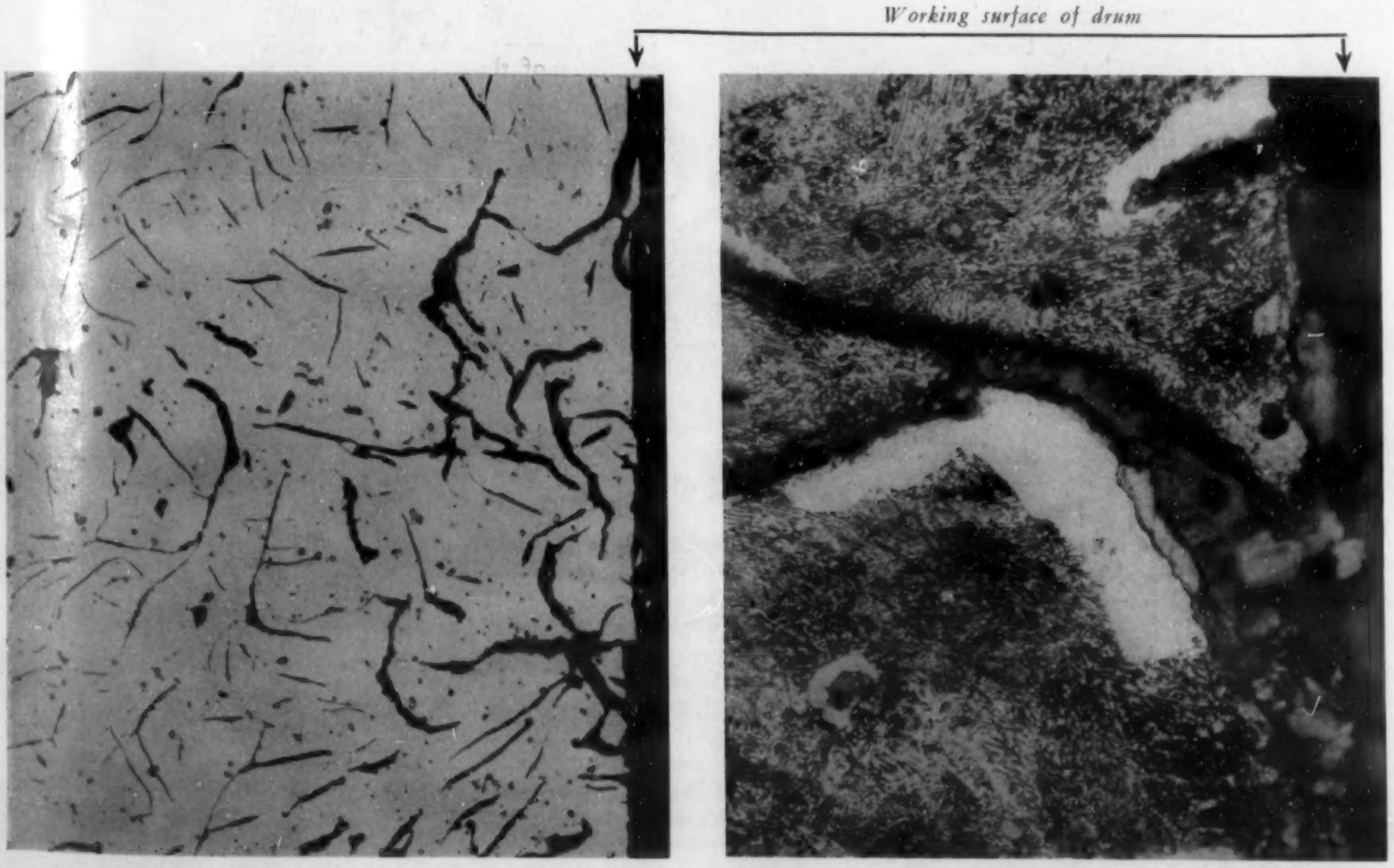
Photomicrographs Figs. 27 and 28 illustrate the etched structure at 100 and 500 magnification respectively. These display a good average form of pearlite. Such a type of pearlite structure will possess average scoring resisting properties if the pearlitic carbide remains stable under the service temperature conditions operating.

Unfortunately, in the presence of such a silicon content, the carbide is thermally unstable at relatively low temperatures and decomposition to ferrite and graphite will occur much more rapidly than with Meehanite "GD" iron. Compare with photomicrograph, Fig. 19. The actual appearance of this drum after dynamometer tests is revealed by Fig. 29.

Photomicrographs Figs. 30 and 31 illustrate the unetched and etched structure through the wearing surface of this drum, at a magnification of 100 times and 500 times respectively. As anticipated, the cracks have penetrated along the graphite flakes while the pearlite has decomposed and flakes of ferrite now surround the graphite. Also the cracks penetrating into the drums are shown to be filled with oxide of iron.

As expected, this drum material proved decidedly inferior so far as resistance to thermal checking is concerned and was only very fair in its scoring value. The discoloration was not so great as the preceding example, but this may have been due to the fact that the cracks did not penetrate so deeply which is more or less expected because the graphite flakes were neither so large nor so numerous.

(To be concluded)



Figs. 30 and 31. Unetched and etched structure of wearing surface of drum at 100 and 500X respectively.

Low-Tin Solders
Containing Silver and Bismuth

by S. TURKUS AND A. A. SMITH, JR.

Federated Metals Div., Newark, N. J. and Central Research Laboratory, Barber, N. J. respectively, Amer. Smelting & Refining Co.

Conservation of tin is of prime importance at present. Due to this urgency, this note is being published as a preliminary report in order to bring to immediate attention the rather promising properties of these low-tin solders. The addition of tin and bismuth to the lead-silver alloys overcomes certain disadvantageous properties and at the same time retains some advantageous ones, according to the results thus far established. It is felt that these solders do constitute very acceptable substitutes for high-tin solders in a great many cases.—The Editors.

LEAD-SILVER SOLDERS have been known for many years but, because of their relatively high melting temperatures and poor spreading properties, they have not found wide use. It has been found that the addition of tin and bismuth to the lead-silver alloys overcomes these disadvantages to a marked extent and at the same time certain advantageous properties are retained. Due to the urgency of the times, and the importance of conserving available tin, this note is being submitted as a preliminary report in order to bring the promising features of these alloys to immediate attention.

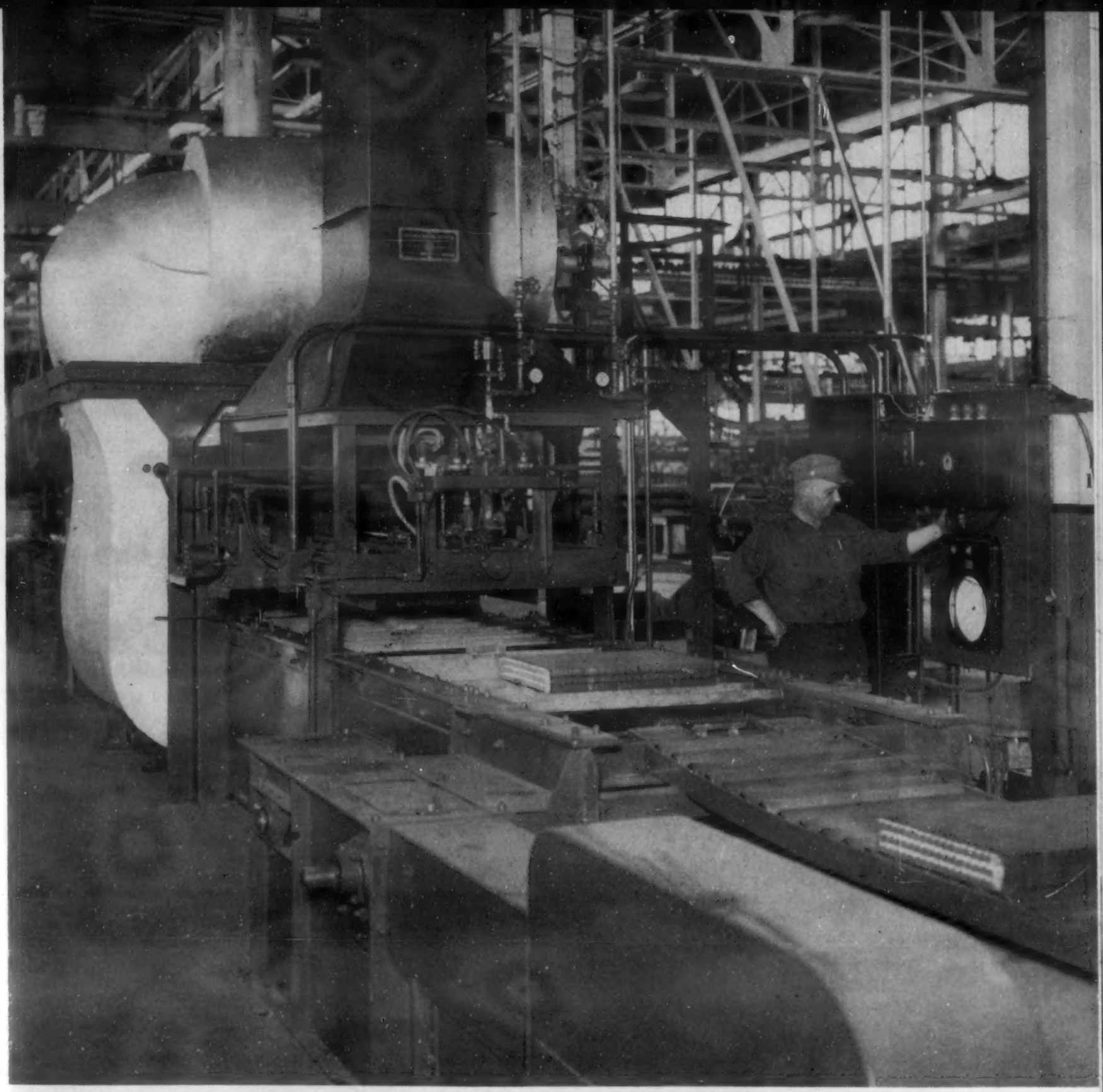
In the accompanying table are given some of the properties that have been determined, using regular tin-lead solders, without silver, for comparison. Carefully standardized testing technique was used for all tests but space does not permit a detailed description of the methods. It is admitted that considerable additional data are needed before the fields of usefulness of the various alloys can be ascertained.

The ternary alloys of lead-silver-tin offer a variety of solders which have somewhat higher melting points than 40-60 solder but relatively good spreading and bond strength properties. Silver added to low-tin solders lowers the liquidus temperature from 6 to 8 deg. C. and appreciably improves the spreading properties with but minor effect on the bond strength. One outstanding improvement of the silver-bearing solders is the increase in creep resistance

Some Properties of Soft Solders

Composition Per Cent					*Liquidus*	*Solidus*	*Tensile*	*Bond strength*	*spread*	*Creep rate in per cent per year at 30 deg. C.*			
Pb	Sn	Ag	Bi	Sb	*deg. C.*	*deg. C.*	*strength, P.s.i.*	*of lapped joints, P.s.i.*	*of ½ Gr. in Sq. in.*	200 *P.s.i.*	400 *P.s.i.*	600 *P.s.i.*	800 *P.s.i.*
60	40	—	—	—	238	183	5,660	6,270	1.30	10.9	92.0	300	—
97.5	—	2.5	—	—	304	304	4,980	3,740	0.19	0.10	0.15	—	0.50
95	—	5.0	—	—	375	304	4,915	4,340	0.20	0.18	0.22	—	0.45
90	10	—	—	—	298	183	4.850	4,960	0.27	2.5	12.0	—	—
87.75	10	2.25	—	—	290*	—	4,950	5,000	0.41	—	2.3	8.0	—
80	20	—	—	—	275	183	4,940	5,680	0.37	6.7	18.7	—	—
78	20	2.0	—	—	267*	—	5,620	5,550	0.57	—	—	—	—
70	30	—	—	—	257	183	5,390	5,770	0.83	10.0	50.0	—	—
69	30	1.0	—	—	251*	—	8,810	5,620	0.86	—	4.0	20.0	—
78.5	15	1.5	5	—	264*	—	4,960	5,310	0.47	—	—	—	—
77.5	15	1.5	5	1.0	258*	—	8,000	5,090	0.29	—	—	—	—
74.85	20	1.5	3	0.5	258*	—	8,120	5,380	0.39	—	—	—	—

NOTE: Bond and spread tests were made on copper sheet.
Tensile and creep tests were made on chill cast strips of the alloys.
* Determined in this investigation from cooling curves—other temperatures from literature.



Automatic soldering of motor vehicle radiator assemblies (Courtesy: Westinghouse Electric & Mfg. Co.)

as shown in the tabulation. These tests have been in progress for only a few weeks or months, and are far from complete but the improvement is striking.

Alloys containing 15 Sn, 5 Bi, 1½ Ag, 1% Sb, balance Pb, or 20 Sn, 3 Bi. 1½ Ag, ½% Sb, balance Pb, have liquidus temperatures slightly higher than that of the 40-60 solders, markedly higher tensile strength and a bond strength of approximately 80 per cent. The spreading properties are less than for 40-60 although much greater than those of the binary lead-silver solders. However, it is believed that, except for a few critical uses, this decrease in spreading properties is not of importance in the making of sound joints. By appropriate adjustment of the tin, bismuth and silver contents, fairly wide ranges of melting points and other properties may be obtained. Commercial trials and rapid hand soldering have been made on some of these alloys with excellent results and automatic machine soldering has also been done with satisfactory results. Cans made on the automatic machine passed all standard tests for 40-60 and 50-50 solders.

Some low tin solders containing silver, or silver and bismuth, that which will surely effect substantial savings in tin consumption have been described in this preliminary note. Both silver and bismuth are available in reasonable quantities and it is probable that ample supplies for solders will be available.

A Rotating Ind

by F. W. SCOTT and T. L. JOSEPH

Assistant Professor and Professor of Metallurgy, Respectively,
University of Minnesota,
Minneapolis, Minn.

Quality control in the manufacture of many metals, and particularly steel, is closely associated with control of the slag in contact with the liquid metal in the furnace. The laboratory study of slag-metal reactions is ordinarily complicated by side reactions between the slag and crucible refractories. The improved type of rotating induction furnace described in this article, however, successfully avoids these difficulties. The article is part of F. W. Scott's Ph.D. thesis at Minnesota Institute of Technology.—The Editors.

THE CONTAMINATION OF MOLTEN SLAG by crucible refractories has been a major difficulty in laboratory studies of slag-metal reactions. This is particularly true of oxidized slags used at the comparatively high temperatures of the basic open-hearth furnace. The rotating liquid crucible described by Barrett, Holbrook, and Wood[1] permits contact between slag and metal but prevents the molten slag from coming in contact with the crucible refractory. Although this type of furnace presents some operating problems, it provides a promising means of studying slag-metal reactions.

Since the work of Barrett, Holbrook, and Wood, the authors have built similar equipment and have further developed several features of experimental technique which greatly reduced the number of unsuccessful tests. Most failures were due to movement of the slag upward along the metal until it reached the refractory and was quickly absorbed. In the present paper, the equipment used over a period of three years to study slag-metal reactions, will be described. Methods for forming special refractories, adding the charge of slag and removing it at the end of the test will also be discussed. In a subsequent article, data on the distribution of sulphur between slag and metal will be summarized.

Principle of the Liquid Crucible

The principle governing the formation of the liquid crucible is well known. If a container, holding a liquid is rotated about its vertical axis, the inner surface of the liquid assumes the shape of a paraboloid under the simultaneous action of centrifugal force and gravity. The internal dimensions of the rotating liquid crucible are dependent upon the diameter of the container and its speed of rotation.

By applying this principle to molten metal, it is possible to form a paraboloid of liquid steel that will act as a crucible in which slag may be introduced and melted. Due to the difference between the surface tension of molten steel and molten slag, the slag will normally remain within the cup of metal and will not come into contact with the crucible wall. In this way, the contamination of the slag by the crucible refractory is avoided.

When such a crucible, its rotating base, and the coils of a high frequency induction furnace are enclosed in a gas tight box, the furnace atmosphere can be controlled. With high frequency induction heating, the temperature can also be controlled within narrow limits. Control of temperature, slag and metal composition, and the gas phase make equilibria studies of the slag-metal reactions feasible.

Fig. 1 shows the arrangement of the inductor coil, the rotating mechanism, and the gas tight box. The table for mounting the coil was constructed from 2 by ¼-in. angle iron with a 3/16-in. steel plate for the top. This steel top was covered by a ½-in. transite board and a ¼-in. asbestos sheet. (See Fig. 2). A hole, 1¼ in. in diameter was cut in the center of the top plate to accommodate the rotating shaft and a brass bearing. The bearing was held in place by a cast iron plate, bolted to the underside of the steel top. Lubrication with heavy grease forced into it by a grease cup prevented excessive wear and any mechanical difficulty at this point.

The vertical shaft, 1 in. diameter and 18 in. long, was reduced to ½ in. diameter at the spindle bearing which supported the entire weight of the rotating unit. This bearing, was made of babbitt, and was bolted, as shown in Fig. 1, to a heavy section of steel channel to give the rotating unit rigidity and to maintain alignment. This bearing is further removed from the furnace and gave no difficulty with normal lubrication. The drive pulley was keyed to the vertical shaft and connected to the electric motor by a round leather belt. The speed of rotation was varied by using different sized pulleys on the electric motor shaft.

A cast iron plate, 5 in. in diameter, was fitted and keyed to the upper end of the rotating shaft. This served as a rotating table upon which the rotating crucible was mounted. As shown in Figs. 1 and 2,

Induction Furnace

a graphite disc to carry the magnesia spindle was bolted directly to this cast iron plate. This magnesia spindle supported a graphite sleeve which held the refractory crucible. A refractory at this point broke the connection between the two parts made of graphite thus reducing the conduction of heat to the rotating mechanism. To obtain good vertical alignment, it was necessary to machine the graphite disc after it was bolted to the cast iron plate and placed on the spindle. A lathe tool assembly was clamped to the table top and the graphite machined to fit the magnesia spindle. Particular care was necessary to make the upper surface of the disc perfectly flat and perpendicular to the shaft. Small deviations from the perpendicular were transmitted to the molten metal, causing sufficient distortion so that the slag was thrown out of the crucible by centrifugal force.

The Inductor Coil

The inductor coil (6 in. outside diameter, 5 in. inside diameter, and 7 in. high) consisted of 35 turns of flattened copper tubing. The 3/8-in. copper

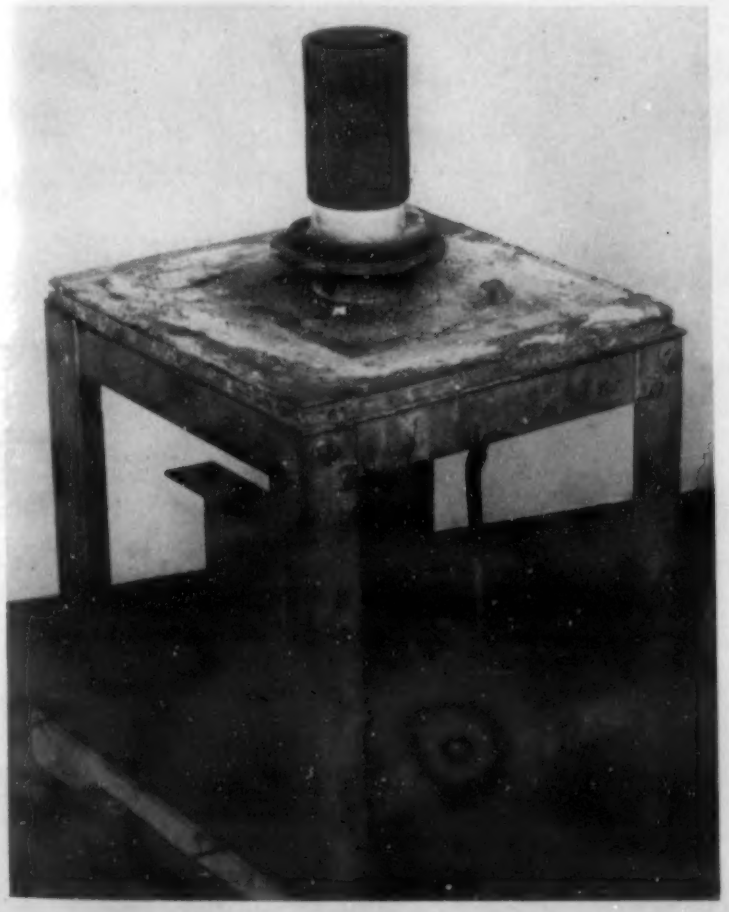


Fig. 2. Furnace base, magnesia spindle and rotating graphite cup to carry alundum crucible.

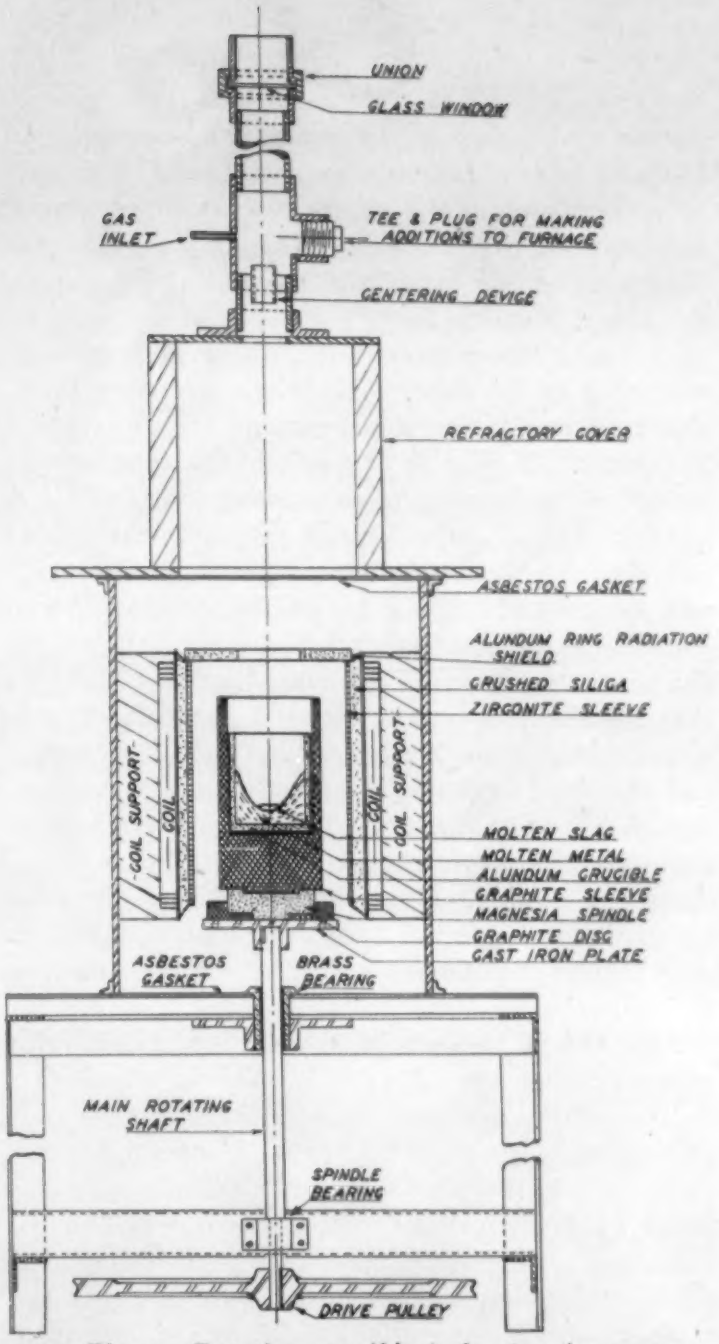


Fig. 1. Rotating crucible induction furnace.

tubing was flattened in a die and wound on a mandrel. After the coil was wound, the oil was removed by naphtha, and the coil was thoroughly coated with Bakelite. Each turn of the coil was separated from the other by a 1/16-in. layer of sheet mica with an inorganic binder.

As shown in Fig. 3, the coil was mounted on one side of a transite-board box, 10 in. by 10 in. and 12 in. high. Electrical leads and cooling water connections were provided on the outside of the box. Pieces of 1 in. by 1/8 in. angle iron were used to connect all corners of the box except those on the side containing the leads to the coil. It was found necessary to use transite in these corners to prevent arcing from the coil to the metal frame of the box. The transite box was fastened to the table by means of angle iron on three sides of the base and transite on the fourth side. (See Fig. 4).

The height of the box directly over the top of the furnace proper was extended because of the high temperature. The smaller upper section of the furnace housing is a monolithic structure, square on the

outside and round in the center. It was made of Lumnite cement and asbestos, reinforced with steel wire, and provided a cover over an open central area 5½ in. in diameter. This central area was finally sealed off by a tube made of pipe fittings. (See Figs. 1 and 4).

The melt was observed through a glass window at the top of this tube. Conditions were very favorable for temperature measurements with an optical pyrometer. A plug on the side of the tube was removed when the slag materials were introduced. A small section of pipe located just below this plug served as a centering device for charging. This pipe was exactly over the center of the rotating, liquid crucible, and accordingly directed the fall of the charge to the center of the cup of metal. Nitrogen gas, containing approximately 0.5 per cent oxygen, was admitted through a ⅛-in. pipe opposite the plug and permitted to escape through a pipe in the top of the table. (See Fig. 2). The rate of gas passage from the box was controlled by means of a pinch clamp on a rubber hose extending below the table top as shown in Fig. 4. Positive pressure, as shown by a U-tube, was maintained at all times to prevent an infiltration of air.

After the furnace was built, the coil was lined with refractory materials. A 1/16-in. sheet of mica which had an inorganic binder was placed next to the coil. (Norca mica by Ajax Electrothermic Corp.) The space between the mica and a zirconite sleeve next to the coil was packed with fine silica. Alundum cement was used to cover the fine silica and to seal the zirconite sleeve to the sheet mica. When the alundum cement had dried, the box and coil were centered on the table and bolted in place.

As shown in Figs. 1 and 3, the alundum crucible, containing the molten metal, fitted snugly into a graphite sleeve standing on a magnesia spindle. To insure good electrical coupling, the clearance between the graphite sleeve and the zirconite lining was held within ⅛ of an inch. This required good alignment in the vertical axis. Any correction necessary was obtained by placing small wedges between the box and the coil supports inside the box as seen in Fig. 3.

When the furnace had been assembled, and the alignment checked, it was sealed with silicate of soda and asbestos fibre made into a paste. Complete sealing was indicated by painting all corners and edges with soap solution which indicated leaks when gas pressure was maintained in the box.

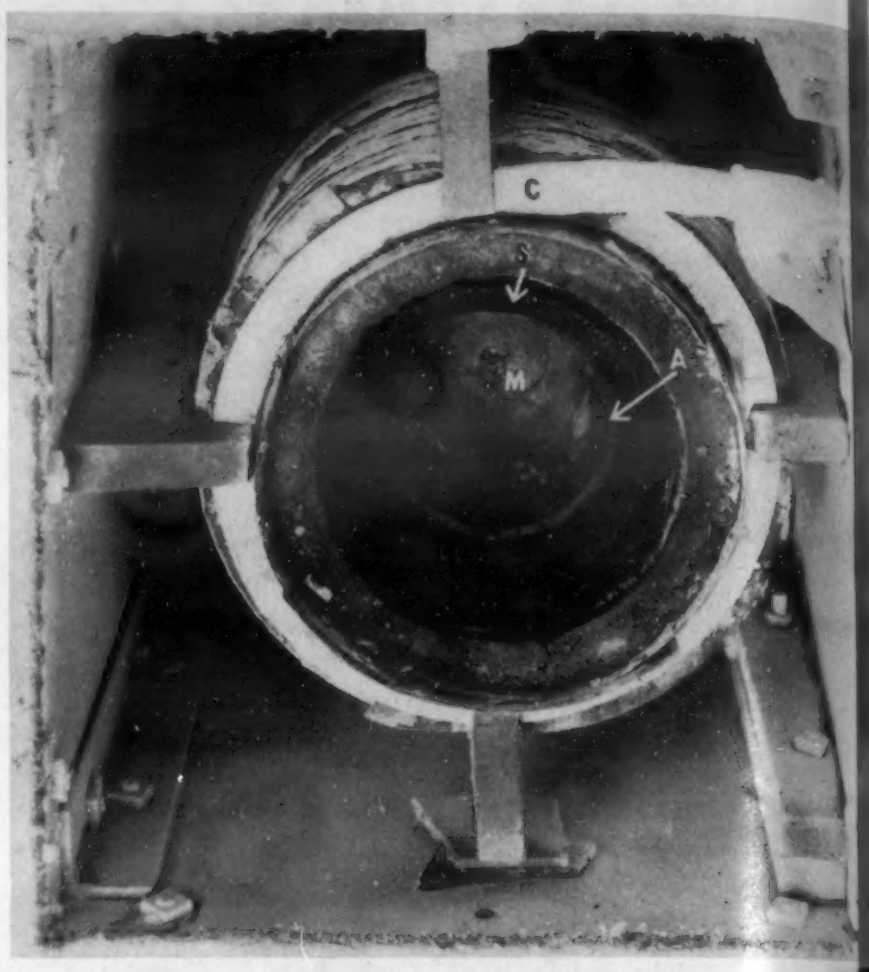


Fig. 3. Top view of furnace proper showing assembly of inductor coil (C), graphite sleeve (S), alundum crucible (A), and metal (M).

Preparation of Refractory Crucibles and Spindles

Metallurgical research involving molten steel and slag at high temperatures presents a refractory problem. The refractories must be able to withstand high temperatures and rather rapid changes in temperature. To procure the necessary refractory articles, commercially, in the sizes and types required would be very costly if they could be obtained at any price. The preparation of these articles in the shape, size, and of materials desired is essential in this type of research.

A means of preparing these refractory articles has been described by E. P. Barrett and W. F. Holbrook[2]. The process involves the making of a mold and a core of graphite, and then packing refractory material into the space between them by means of a vibrator. With the cores and molds held together on a foundry vibrator, finely divided refractory materials were poured into the holes shown in the three cores to the left of Fig. 5. The mechanical action of the vibrator produces a dense packing of the dry refractory. The refractory is much more compact and more uniform than could be obtained by ramming the moist material into the mold.

When the form would take no more dry material, the mold was removed from the vibrator, and the refractory moistened by a solution of silicate of soda (0.5% solution) or by a solution of boric acid. After the refractory was moistened, the core could be removed without the form losing its shape. After careful drying of the refractory, the mold and re-

fractory were placed in an induction furnace, heated slowly to 1700 deg. C. and then cooled slowly. At this temperature the material sintered sufficiently to form strong refractory articles, resistant to thermal shock.

Graphite forms and cores used in making alundum crucibles, magnesia spindles, alundum radiation rings, and the zirconite sleeve used as the furnace lining are shown in Figs. 5 and 6. Electrically fused alundum, 100 mesh, was found most suitable for the alundum articles. Pure magnesia, 100 mesh, was used for the magnesia articles. The silicate of soda solution was used to moisten the alundum refractory, and the boric acid solution to moisten the magnesia.

Magnesia was used at one time as crucible refractory and for the radiation rings. While it was suitable as a refractory, the high temperature caused a white sublimate or fume of MgO to form in the furnace. This fume interfered with the reading of the temperature by the optical pyrometer. For this reason alundum was substituted for magnesia in all cases except the spindle. The magnesia spindle was retained as the base supporting the rotating unit because it could be machined in the lathe, thus permitting the best possible alignment of the rotating crucible. Very little fume came from the spindle as it was removed from the zone of high temperature.

The zirconite sleeve was made in the split graphite mold shown in Fig. 6. The core was wrapped in two layers of brown paper to allow for the shrinkage. The split mold was wired together and the dry refractory packed into the form on the vibrator. The packed dry refractory was moistened with a solution of silicate of soda. After drying, it was placed in the furnace, slowly heated and burned at 1600 deg. C. By the time the paper burned out, the refractory had taken a set. As the temperature rose the wire melted but the refractory sleeve retained its shape, and finished 1/8 to 3/16 in. in thickness. Zirconite was used rather than magnesia as the latter cracked badly when the furnace was heated and cooled. Magnesia sleeves also were responsible for some fume in the furnace.

The time of heating required to form a ceramic bonded refractory was dependent upon the thickness of the section. Usually the time could be approximated by watching the refractory article. When it shrunk enough to be free of the mold, and not

Fig. 4. Furnace proper in foreground with converter unit and power control in the rear.

enough to be deformed or undersize, the heating was complete.

Preparation of Slags

The preparation of slag constituents in a form suitable for charging into the rotating metal crucible proved to be a critical phase of experimental procedure. It was found, after experiencing some difficulty, that pure powdered silica and pure calcined calcium carbonate could be briquetted after moistening by compressing in a steel cylinder. These cylindrical briquettes were dried and held at about 600 deg. C. until ready for use. Even though the powdered components were intimately mixed, the briquettes melted slowly. These briquettes, especially the most basic ones, floated on the surface of the rotating molten steel before melting and had a tendency to move up the sides of the molten crucible until they contacted the alundum crucible and were rapidly absorbed. This resulted in fluxing and the formation of low melting constituents that soon produced a hole in the side wall of the crucible.

Experiments indicated that the melting of the briquette was facilitated by absorption of iron oxide from the metal. Further tests showed that the speed of melting could be increased by dropping small pieces of magnetite on the briquettes. In the procedure finally adopted, magnetite was added to the briquettes of all basicities. As all the tests reached equilibrium with iron oxide in the slag, the amount

Fig. 5. Graphite forms and refractory parts. Bottom —graphite core, mold and alundum crucible. Middle —graphite core, mold and magnesia spindle. Top— graphite core, mold and alundum radiation shield.

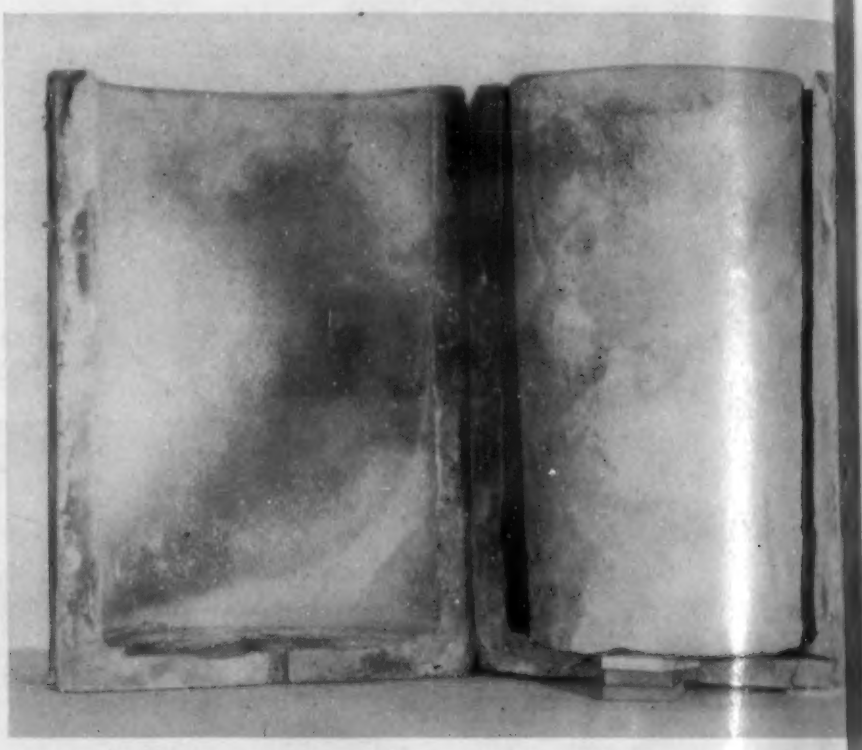


Fig. 6. Split graphite mold for making zirconite sleeve.

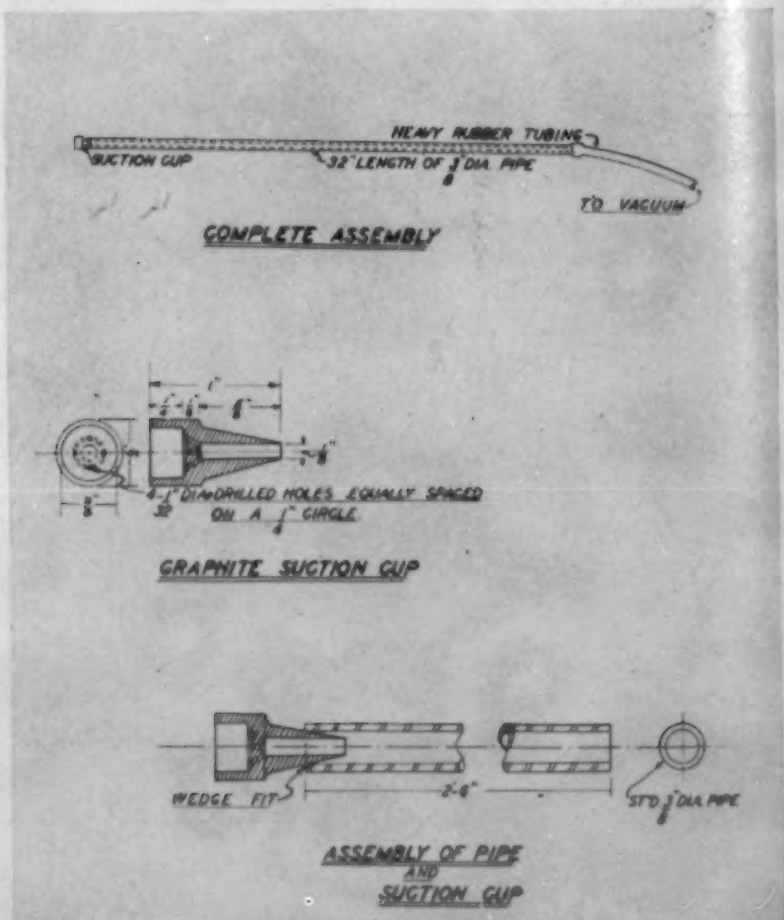


Fig. 7. Device for removing slags from rotating furnace.

used to facilitate melting was not critical. In most cases, 5 per cent Fe_3O_4 was added to the lime-silica powders before briquetting.

The synthetic slag mixtures that were added to the molten steel containing appreciable amounts of manganese, contained manganese dioxide in a powdered form. For example, the slag mixture used on the steel bath, containing 0.25-0.40 per cent Mn, contained 5 per cent MnO_2 while the mixture used on the steel bath containing 0.70 to 1.00 per cent Mn contained 10 per cent MnO_2. The slags containing 5 per cent MnO_2 melted satisfactorily but those containing 10 per cent MnO_2 were difficult to melt. It became apparent after a few tests that magnetite was better than MnO_2 in forming a liquid slag. The addition of small amounts of oxide early in the test did not alter the composition of the slag at equilibrium. However, the fluid oxidizing slags, or those containing iron oxide, formed more readily and reduced the number of failures due to the contact between the slag and refractory crucible. Again this was most pronounced in the basic slags to which MnO_2 had been added. As a result, most of the tests in manganese series were made with slags containing iron oxide.

In tests made over metal deoxidized with silicon and carbon, the initial slag mixture contained 5 per cent Fe_3O_4. These slags melted readily and the iron oxide was rapidly reduced from the slag, but not before the lime and silica had reacted to form liquid calcium silicates. With a rather thin layer of liquid slag in contact with the metal bath, equilibrium was quickly established.

Removal of Slags from the Rotating Furnace

To obtain data representing equilibrium conditions with respect to sulphur distribution between slag and metal, it was necessary to develop a technique by which the slags could be removed from the surface of the metal, at the existing temperature. Moreover, the slag, so removed, had to be chilled instantly to prevent any change in composition.

The first procedure for removing the molten slag was to chill it on the pointed end of a heavy cylinder of copper. When the slag was touched by the copper tip, it was instantly chilled and could be withdrawn. This method was difficult to operate because the view into the crucible was obstructed by the copper cylinder. With the view partially cut off and the crucible in motion, it was difficult to just touch the slag and not make contact with the steel. Moreover, if the cylinder was inserted too slowly, the tip was heated so hot that the slag would not chill completely and would drop off while being withdrawn from the furnace. This meant the loss of the test.

After only partial success in removing the slag with a copper chill bar, a better scheme was devised. The slag was removed by drawing it, with suction, into a graphite cup, where it was instantly chilled. As shown in Fig. 7, the small graphite cup was fitted snugly into the end of a ⅜ in. diameter pipe. This pipe was connected to a vacuum pump by means of a length of rubber tubing. When the cup came into contact with or into very close proximity of the molten slag, it was instantly drawn into the cup, and chilled.

The four small, 1/32-in., holes connecting the cup to the suction were filled with solid slag thus preventing the slag from entering the pipe. The slag remaining on the bath was not disturbed to any great degree, and four or five cups of slag were often removed. The small diameter of the pipe and the cup allowed a good view of the slag during the operation, and as a result very few melts were lost because of inability to remove the slag and chill it to prevent any reaction with the metal below the temperature of the test.

Temperature Measurement

The temperature of the bath was measured by means of an optical-pyrometer sighted through the glass window at the top of the tube. The inside of the tube had been blackened with lamp black to avoid light reflection. The rotating crucible offered a rather difficult target, but the line where the slag and metal met was used to measure the temperature. This closely approximated black body conditions.

A platinum to platinum rhodium thermocouple was used to calibrate the optical-pyrometer. A large section of graphite electrode had two holes drilled in it, one to hold the silica tube containing the thermocouple and the other, a larger one, to serve as the target of the optical pyrometer. Both holes were drilled to the same depth, were close together, and the bottom of each was believed to assume the same temperature when the graphite was heated. The graphite electrode section was placed in an electric resistance furnace. A tube made of pipe fittings, with a glass window, was placed over the hole in the graphite block, and clamped in line with it.

The furnace was slowly heated, and the thermocouple readings were checked against simultaneous optical pyrometer observations obtained by sighting on the closed end of the hole in the graphite block. Readings were taken up to 1550 deg. C. and the curve was extrapolated at 1700 deg. C.

The calibration of the optical pyrometer was further checked against a standard filament lamp. These calibrations assured accurate standardization of the pyrometer.

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[2] E. P. Barrett and W. F. Holbrook. "An Improved Method for Forming Fused Magnesia Crucibles," *Ind. Eng. Chem.*, Vol. 10, 1938, pages 91-93.

Phosphate Coatings on Steel

By HERBERT CHASE

Installation for both Parkerizing (at left) and for (at right) Bonderizing parts in a United States Government arsenal.

The inhibition of corrosion is an ever present problem. There are several methods of alleviating the tendency of certain materials to corrode, and those described in this article are widely used.

The engineer or designer, who desires to know what products are today being subjected successfully to phosphate treatments, will obtain considerable information in this article. Particularly in these days are such data valuable.—The Editors.

APPLICATION OF PHOSPHATE COATINGS to inhibit corrosion and serve as a base for paint or for other finishes may appear, to the casual observer, to present little that is new. A study of the facts, however, soon makes it apparent that the use of such coatings is not only increasing but is becoming more diversified.

Moreover, the process itself has been speeded and rendered more economical. It has, in fact, kept pace with modern industry and is continuing to do so. For example, a treatment which some 10 years ago required a minimum of about 10 minutes, can now be done in about one minute. At the same time, the temperature which has to be maintained in the treatment has been materially reduced, making for economy in steam consumption. In some instances, the size of equipment needed and the space required has been greatly reduced, again tending to lower costs.

Several Products Now Treated

Treatment is by no means confined today to black iron and steel. Galvanized and other zinc coated surfaces as well as zinc alloy die castings are treated with great benefit, especially in respect to paint adherence. Cadmium coated surfaces can also be treated with similar results. A treatment has also been developed for iron and steel surfaces which have been machined and by which rapid wear on these surfaces during run-in periods is avoided. This treatment helps to maintain required clearances and also results, in some instances, in a noticeably quieter operation of engines.

Phosphate treatment is being extended to include structural shapes and assemblies and is now employed also in a continuous process for the coating of both black and galvanized strip stock and wire. It extends to the processing of many munitions items which, without the application, would prove much more difficult to maintain in the required condition for service.

These improvements are a direct result of continuous research and development carried on, especially in the laboratories of the Parker Rust Proof Co., Detroit. These laboratories are constantly engaged in the solution of problems encountered by individual customers and in broader studies designed to lower the cost of treatment and thereby to extend the use of "Parkerizing," "Bonderizing" and "Parco-Lubrizing." Independent and strictly impartial tests have also been made at the Bureau of Standards, Washington, as well as in other laboratories.

In a recent report of the Bureau of Standards, in which a large number of treatments for the corrosion protection of steel, both galvanized and black, were compared (Report BMS 44), the following significant statements appear:

"The pre-treatments for galvanized steel surfaces which gave the greatest improvement to the protective value of paints subjected to salt spray tests, were the hot dip phosphate treatments. These treatments . . . . were definitely superior to all others tested." In salt spray tests on plain (ungalvanized) panels, "the hot dip phosphate treatments have been found consistently best in improving the protective value of paints applied over them." "Hot dip phosphate treatments stood up best in accelerated weathering tests." This applied to both galvanized and black iron test panels. "Hot dip phosphate treatments showed outstanding merit in all the accelerated laboratory tests. Improvement in protective value of paints in the accelerated weathering tests may be attributed chiefly to improved adherence. . . . The phosphate film deposited by these treatments aids materially in slowing down corrosion underneath the paint."

Phosphate Treatment of Galvanized Products

Among the most important of the more recent applications of phosphate treatments on a large scale are those employed by steel manufacturers for the treatment of galvanized products. It is well known, of course, that paint applications over galvanized steel frequently result in early peeling of the finish unless special precautions be taken. It was formerly quite common practice to allow galvanized surfaces to weather for some months before painting, but, when this is inconvenient, etching with acid, which destroys a part of the coating, thus decreasing its protective ability, is sometimes employed.

Either expedient is somewhat uncertain as both depend in part upon the judgment of the painter and his willingness to apply etching acid properly and to remove it completely thereafter, or to wait until weathering takes place and then to clean the surface of any foreign matter which may have accumulated on it. It is much better practice to apply a phosphate pre-treatment at the steel mill after galvanizing is done, as then the cleaning and pre-treatment (with phosphate materials) can be controlled as it should be, and the process can be done with uniform results and at minimum cost. The American Rolling Mill Co., Carnegie-Illinois Steel Co., Bethlehem Steel Co., and Newport Rolling Mills are all equipped to supply Bonderized galvanized sheets that promote paint adhesion.

In the Motor Car Industry

Severe exposure conditions are encountered, of course, by much of the steel sheet employed for fenders, hoods and other parts of the modern motor-car body and associated parts of the chassis. Such sheet metal, as well as many exposed bolts and nuts and a variety of chassis elements not formed from a sheet are, of course, subject not only to all extremes of weather, but to road dirt of every description, as well as to exhaust gases and often to the salt applied to prevent snow accumulations on the streets of some cities.

No matter how good the applied finish may be, it is sure to be scratched or abraded at some points and, unless an effective rust inhibitor is employed, corrosion proceeds rapidly, even under the paint. For this reason, practically all passenger car manufacturers employ a Bonderizing or Parkerizing treatment for the types of surfaces mentioned and those which are exposed to view receive, in addition, coats of baked enamel or some equivalent finish, the adherence of which is greatly improved by the pre-treatment of the steel. Many die cast parts which are not plated receive a similar treatment. The result is a finish of remarkable endurance, in view of the severity of service encountered.

Some of the earlier forms of Bonderizing involved a slight dusting of the deposit, which made it necessary to tack-rag the surface before applying priming coats, but the modern Bonderizing eliminates dusting troubles and is rapidly performed.

Automobile body assemblies, such as that shown entering a Spra Bonderizing inclosure, are among fabricated products which are benefited greatly by phosphate coatings applied by the latest methods.

In Some Other Industries

Great success, attained with phosphate treatment in the automotive industry, has naturally resulted in its rapid extension to many other industries. One such is the refrigerator industry, partly because the corrosion of steel sheet is rapid, of course, where cold surfaces induce condensation, unless a suitable inhibitive treatment is employed. The same is true in respect to washing machines and some makers of these put the die cast parts, of which there are several, through the same Bonderizing treatment given the steel portions.

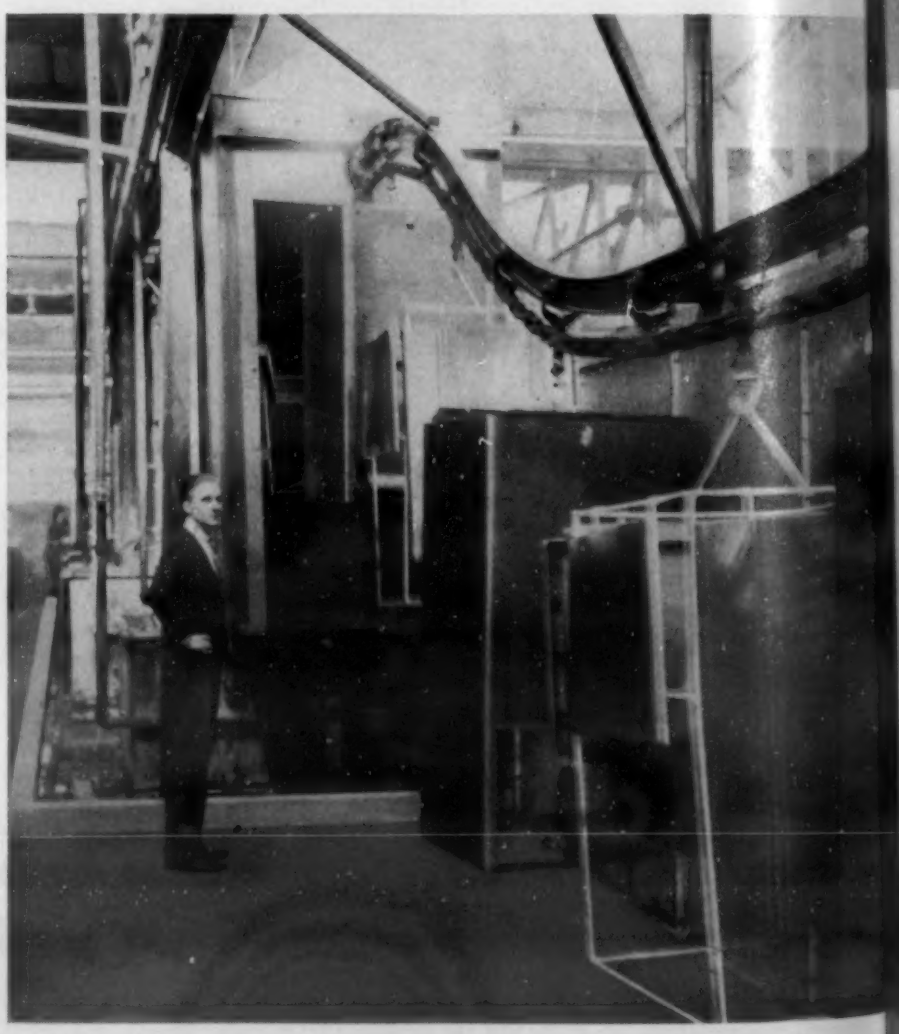
There is, today, an extensive use of phosphate treatments for parts of air conditioning systems, some of which are applied to galvanized surfaces and some to black steel. The treatment is of special importance where condensation occurs, where the metal comes in contact with water sprays or air of high moisture content and where exposed parts of the system require an applied finish which may be subject to peeling or rusting unless there is applied a good base for paint.

Also increasing is the use of phosphate coatings for steel, both black and galvanized, which enters into building construction. This is especially true of metal window sash and of other parts which are exposed to weathering and must be painted. Such parts, unless given a phosphate coating after fabrication at the factory, may be rusted even before they are installed. But whether rusting takes place before or after installation, it is likely to result in need for early and frequent refinishing, the cost of which greatly exceeds that of applying a rust inhibiting phosphate coating before the product leaves the fabricating plant.

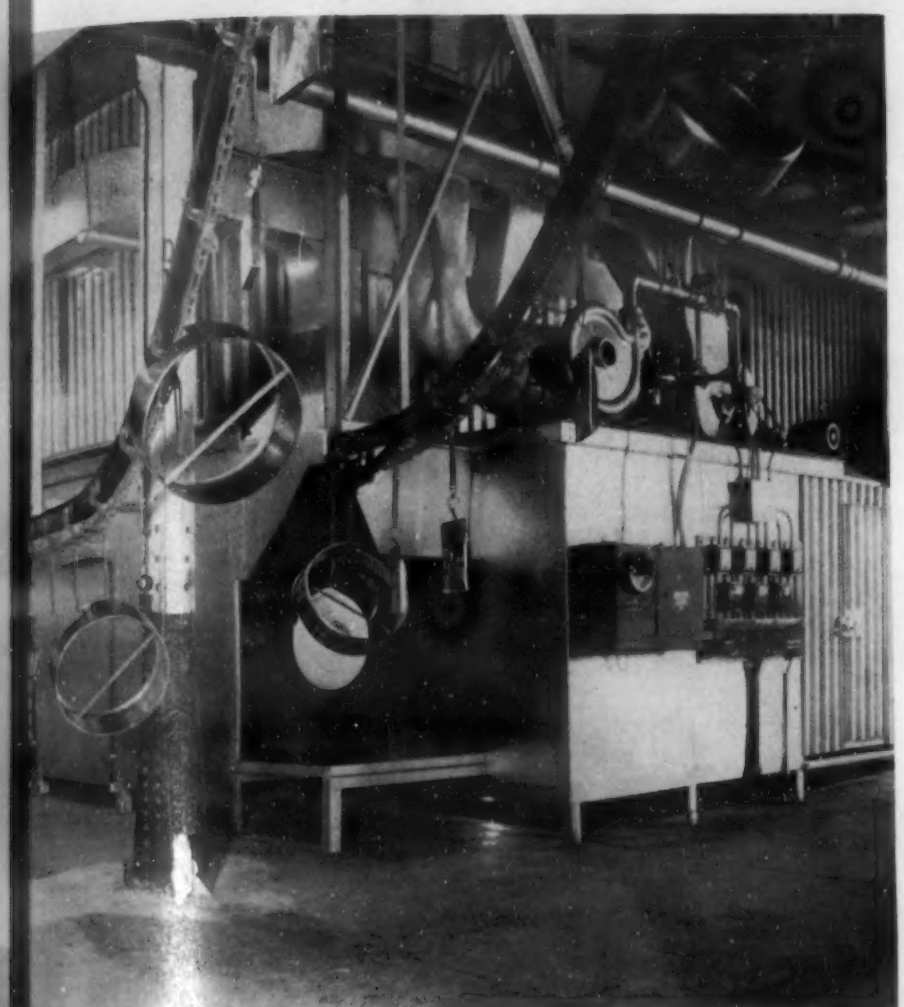
In Boat and Ship Building

Phosphate coatings appear to have gained comparatively little use in boat and ship building, at least in proportion to the benefits which might be derived from their use. Doubtless this is partly because parts, which might well be thus treated, are fabricated in small lots under conditions in which tank or spray application equipment is not too readily made available. There is little doubt, however, that great savings in maintenance could be effected if boat and ship fabricators, who are large users of steel, would

Conveyor carrying refrigerator parts to be Bonderized into an inclosure designed for cleaning, continuous application of a phosphate coating, and final rinsing and drying of the product.



Washing machine parts, including those of sheet steel as well as those die cast in zinc alloy, on a conveyor which carries them through a Spra Bonderite treatment.



give the subject of phosphate treatment some study, with a view to adapting it to their particular uses. At least one manufacturer of boats having steel parts is already applying phosphate coating to some of them with favorable results. These posibilities are chiefly in the above-water portions of the boats.

Makers of electrical products (as distinct from electrical appliances, already referred to) are among those who find phosphate treatments beneficial on some of their goods. Among these are transformer housings of the type applied on poles or used elsewhere in moist atmospheres or where direct weather exposures prevail. Such applications, of course, are severe on applied finishes and make it especially beneficial to use a pre-treatment which inhibits rust and promotes paint adhesion.

For Smooth Surfaces

Bonderite treatment finds its chief application on surfaces which are relatively smooth and which are to receive subsequent coats of paint or finishes which are subsequently baked on. Although Parkerizing, which provides a similar phosphate coating, is also a good base for paint, it is employed more especially for machine and other parts which do not require painting. Coatings produced by Parkerizing are highly absorbent and the product is usually dipped subsequently into a mineral oil or wax, much of which is absorbed and retained by the phosphate coating. If a deep black is desired in favor of the grayish finish left by Parkerizing, a dipping in Parkolac, which contains a dye, is often done. Surfaces resulting from Parkerizing and subsequent dipping or spraying of oil or oil-like products are commonly not lustrous but can be given a luster by buffing. Bolts, nuts and screw machine products are among those Parkerized in large quantities and the coating is applied uniformly to threads, as well as to other surfaces, but without any significant change in dimensions. The coating does not readily chip or rub off. Castings and forgings as well as stampings and other iron and steel parts and die castings are often Parkerized, as are a variety of assemblies, both large and small. It is necessary only to provide equipment suitable for the size and type of part to be dipped.

For Camshafts and Other Engine Parts

To date, the chief use of the Parco-Lubrite treatment, which is quite similar to Parkerizing, has been

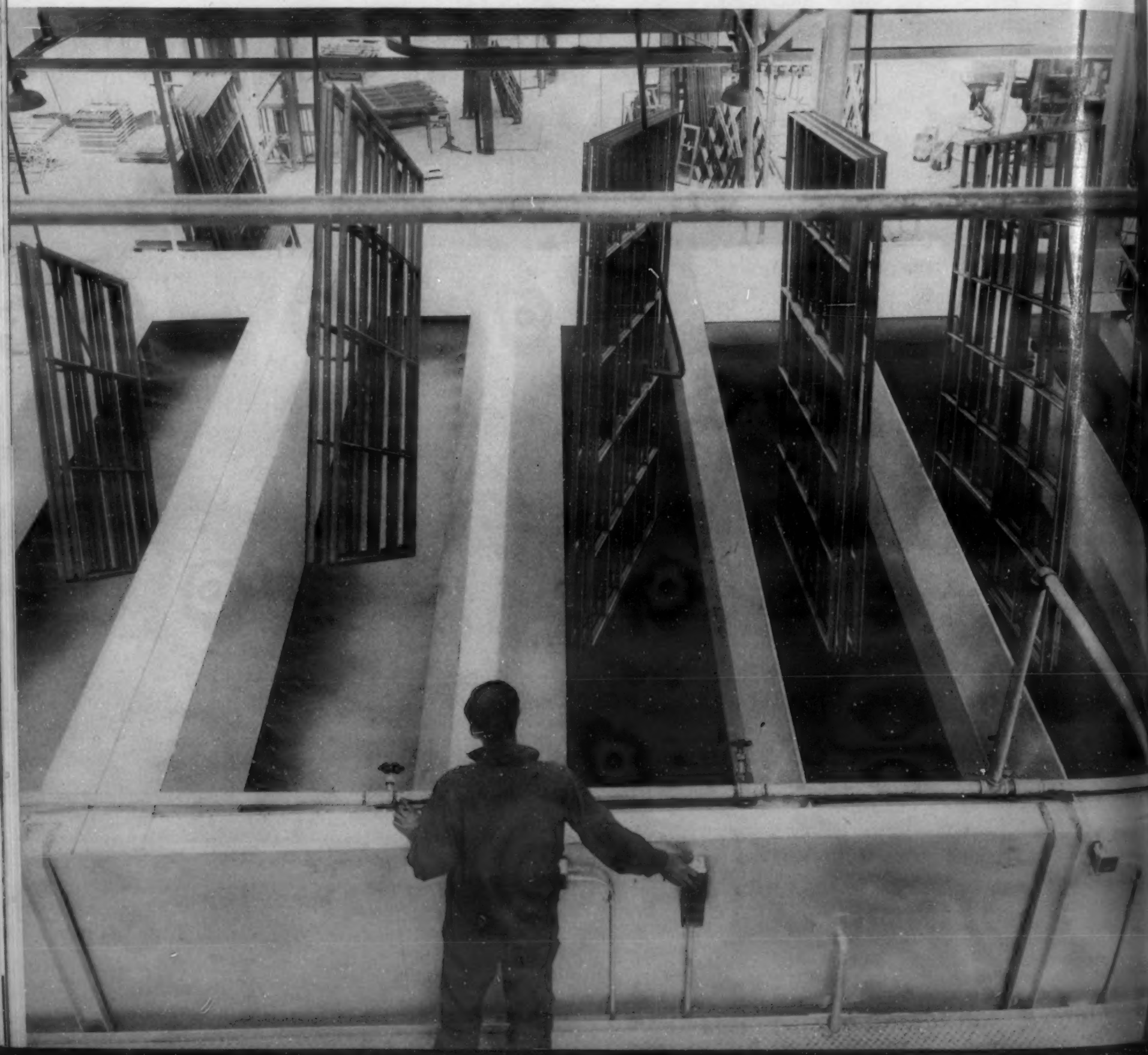
In these tanks, grilles for air conditioning systems are cleaned, given a phosphate coating, and then are rinsed and dried prior to application of final finish.

in treating such parts as camshafts, valve tappets, piston rings and rocker arms of automotive engines. The phosphate coating which results from the treatment is an excellent rust inhibitor, but its chief function is to absorb and retain lubricant, which it does effectively. After treatment, the parts are dipped in a soluble oil to which colloidal graphite is sometimes added. This results in a surface which is highly wear resistant in normal use and which does not cut the surface on which it bears, especially during run-in periods. Parts thus treated are reported to undergo practically no wear during 50-hr. run-in periods, during which the same parts without the treatment wear from 0.001 to 0.0015 in. One benefit of the treatment is that the resultant coating retains oil indefinitely on bearing surfaces, because of the porous nature of the coating.

Further examples of the utility of phosphate coatings could easily be cited, but those already mentioned give some picture of the present status of such coatings. Rapid growth in their use is indicative of their value and of the developments which have reduced their cost of application.

Of course, phosphate coatings are not the only useful ones. Chromate coatings have decided value for some uses, and still other interesting coatings are in process of development. And in such a connection, anodizing of aluminum should not be forgotten. But these are other stories.—*The Editors.*

Modern installation for Bonderizing steel window sash, subsequent to fabrication.



Parts of the type here shown are among those for automotive applications which have received a Parco-Lubrizing treatment to minimize wear on bearing surfaces.

Transformer shells on the conveyor after emerging from Bonderizing treatment in the plant of a large electrical manufacturer.

EDITORIAL

(Continued from page 395)

a big one and—as they are doubtless aware—it obviously cannot be solved by them alone. But their work is a worthwhile beginning and it is hoped that their recommendations will be a good foundation upon which to build the solution of the formidable problem of post-war conversion, economy and rehabilitation.

—H. R. C.

A Fortieth Anniversary

Forty years ago—on March 21, 1902—seven men incorporated the American Society for Testing Materials. They were: Henry Marion Howe, Charles B. Dudley, Edgar Marburg, Robert W. Lesley, Mansfield Merriman, Albert Ladd Colby and William R. Webster—all men who have made a deep and lasting impression in many fields of endeavor. The most optimistic dreams and ideals of these men have been realized and perhaps exceeded—the work of this technical society today is of the highest order and of great value to many industries. The vision of its founders has been fully justified. "Whether Walter Pitkin with his 'Life Begins at Forty' is right or wrong, there's a great deal of life left in the old 'gal' yet." The prejudice in some quarters that 40 years is the limit of usefulness of men in industry should be decidedly rejected. It is certainly not true of such a society.

—E.F.C.

Letter to the Editor

Crystallization Again!

To the Editor: Your reference page 37, January METALS AND ALLOYS, "Crystallization Again!":

Why the inference that everyone, including the makers of tubing, are wrong, likewise, the questionable stand taken on normalizing?—"doubtless does no harm, and probably doesn't do a bit of good"?

The people that make the tubing and the people that use the tubing must apparently subtract daily from the sum of pipe knowledge.

— Likewise —

Crystallization is a worker's phraseology.

Damage is a foreman's phraseology.

Fatigue is a technician's phraseology and whether they be right or wrong they mean the same thing in the basic thought language of today.

7 Milburn St., McKeesport, Pa. L. M. HELMSTADTER

Sure, a rose by any other name would smell as sweet, but when you order rose bushes from the nursery, it's a convenience to have the word rose mean rose, not skunk cabbage or poison ivy.

And in respect to phraseology, Mr. Helmstadter's phrase, that people who do needless things because that's the way they're used to doing them, "subtract from the sum of knowledge," is a good one.—H. W. G.

A Few Chuckles

A Substitute for Nickel Silver?

In the "Industrial Reference Service"—U. S. Dept. of Commerce, issue of November 1941, Business Series No. 22, entitled—"What can be substituted for materials needed for Defense?"—by Ruth C. Leslie, Dept. of Commerce, appears the following:

Article	*Material Substituted*
Nickel Silver	Reducing silver content or replacing with brass or bronze

Thought you would like to learn about this genius-becoming contribution. —C. A. DAVIS, JR.

A New Babbitt!

Eng. Mining J., December 1941, page 100, reports A new babbitt metal with "a tensile strength of 17,500 lbs. per sq. in., a yield point of 65,000 lbs. per sq. in" etc.

—H. W. G.

A Hot Heat of Steel!

Sat. Ev. Post., Feb. 14, 1942, page 53—Prince Albert adv.—

"Wonders of America, Drama in Steel"

"That heat of steel is around 8,000 deg." —H. W. G.

The A.I.M.E. on the Metals Front

A REPORT OF THE ANNUAL MEETING, NEW YORK, FEB. 9-12

By THE EDITORS

WARNING: *This report (and those of other meetings to come) is probably unlike any report of a technical society meeting you have ever read before. It is more "personal," for one thing (although none of the editors will agree to sign it), than the customary resume of a convention, and it is loaded with interpretation, editorializing, ad-libbing—and dynamite. It is simultaneously an appraisal of the meeting's significance to our readers and a record of what it actually did and said.*

This is, in short, the A. I. M. E. meeting as it looked and sounded to the entirely human editors of METALS AND ALLOYS. *Their own interpretations, reactions, concurrings, demurrings and even whimsies are all interspersed with the cold hard technical facts and data taken from the papers, discussions, lectures and speeches. No attempt has been made to present a complete report, but rather to emphasize those items that appear to be of the greatest interest to metallurgical* engineers—*which means those items that struck* our *fancy, funny-bone or firing-pin.*—The Editors.

THAT SPRAWLING ORGANIZATION, the American Institute of Mining and Metallurgical Engineers, held its 156th meeting in New York, Feb. 9th to 12th. Although outnumbered in a total registration of 2,568 by hordes of geologists, mining engineers, coal people, petroleum men, nonmetallic mineral experts and pedagogues, the valiant and articulate metallurgical engineers and physical metallurgists made up in intensity and vitality what they lacked in numbers. Altogether some 40 papers were presented by and for them alone, with subjects ranging from the use of sulphites in steelmaking through the rolling of brass down to (or up to, as you please) the rate of growth of intermediate alloy layers in structurally analogous systems.

From where we sit (with the added perspective gained by two weeks of procrastination in writing this to aid us) the meeting seemed to have been nicely slanted toward the war effort, and the impact, presence or imminence of war-production problems and material-supply considerations was felt in every session. It has become trite to refer to this conflict as a "war of metals," but such a description is nonetheless true, and the A. I. M. E.—as an organization and as individual members—was obviously aware of the group's present responsibilities and potential service in that direction.

This report will consciously emphasize those sessions and papers that were concerned with war production problems—the big general session on "Ores, Metals and the War," the papers on steelmaking, the group of papers on hardenability, the "time-is-of-the-essence" Howe Lecture of Dr. Johnston and the meetings on copper and brass. Some of the social, personal, and professional sidelights of the 4-day convention are scattered among these pages, inside the little boxes that you see here and there.

Ores, Metals and the War

There is no doubt that the single meeting of broadest importance during the whole week was the general session Tuesday afternoon on "Ores, Metals and the War." The program was designed to acquaint men in the metal-producing and fabricating fields with the present conditions, and what they might expect in the future, as well as to give them information to aid them in their individual war efforts.

There is always the danger in sessions of this kind for the speakers to indulge in meaningless statistical surveys or to give impassioned pep talks out of which come few constructive suggestions and little information of practical value. The "Ores, Metals and the War" session was noticeably free of these faults. The papers were interesting and informative, contained pertinent statistics and provided for metallurgical engineers a clear picture of the war production situation.

Perhaps one of the reasons for the scanty use of statistics was the busy blue pencil of the censors. R. E. McConnell, engineering consultant, WPB, and chairman of the Engineers' Defense Board, was scheduled to speak on the comparative metal supplies in 1942 of the United Nations and the Axis Powers. The censors, however, figured such a comparison might be helpful to the eavesdropping enemy and misleading to many people in this country. Specific production figures at best can be only estimates and at the same time they are controversial and are likely to be misinterpreted, usually in the wrong direction. So Mr. McConnell spoke about certain vital war-production factors of which the enemy has been aware for some time, but which we have been prone to disregard.

One of these factors he mentioned was the distance of our war production centers from the line of battle. If for no other reason then our tremendous distances from the war areas, our total "war production" must be far greater than that of the enemy's. In addition to the metals needed for the front line implements of war, we need metals for a vast fleet of ships, trains and trucks of all descriptions to transport the materiel from the production front to the battle front. This is an added production burden with which the Axis does not have to contend to such a degree.

Conserving Man Power and Materials

Another important factor to consider is that of production personnel. The engineers, McConnell rightly pointed out, are collectively the most important group of men in this war except for the military officers. It is their responsibility to see that our war production is superior in every way to that of the Axis.

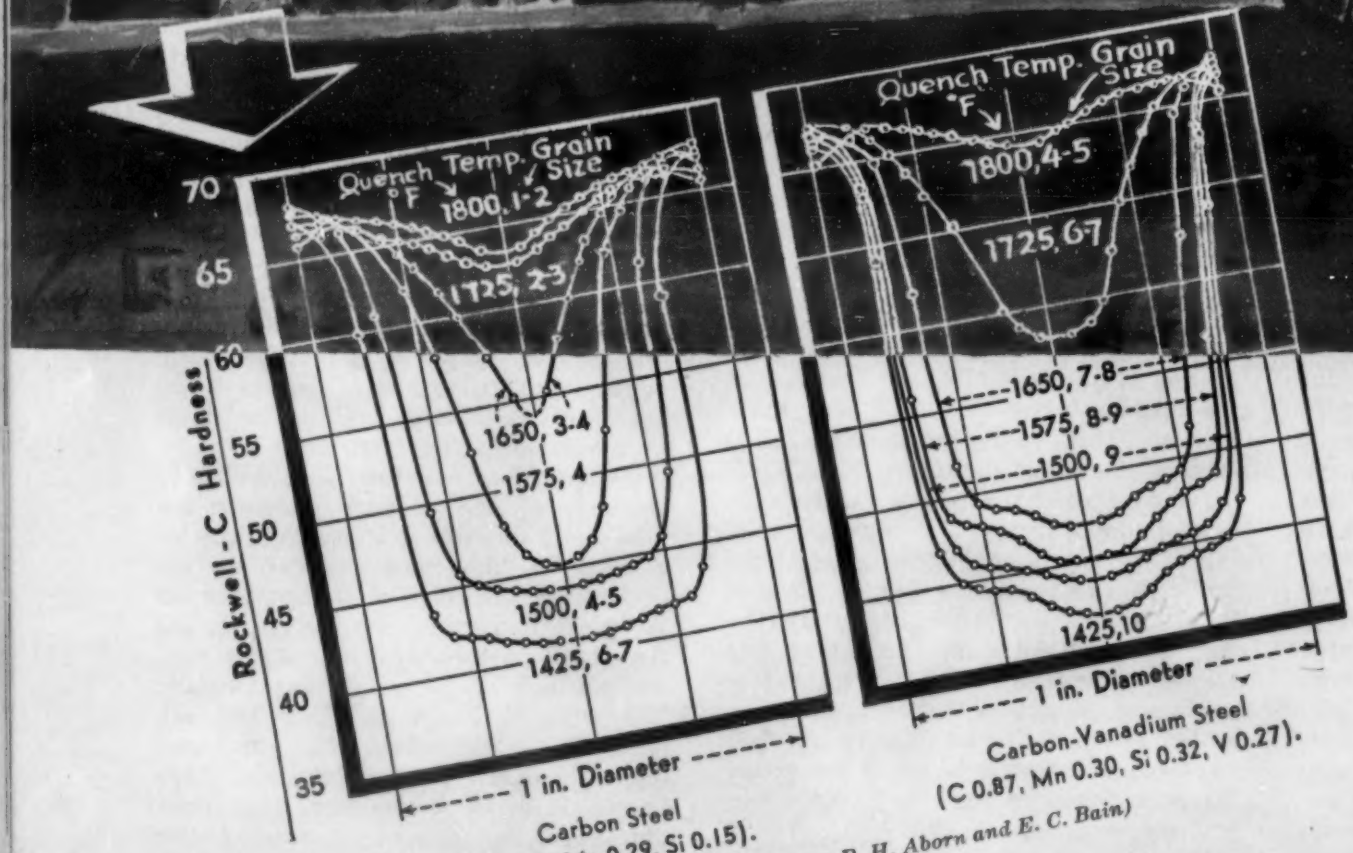
Mr. McConnell placed the number of engineers in this country at 300,000 and added that we are short 1,000,000 technically trained men to do the job that needs to be done. He failed to make himself clear as to what he meant by technically trained men, but the figure obviously included highly skilled workers and technicians as well as full-fledged engineers. Nevertheless, the point remains that there is a serious shortage of engineers as well as technically trained men and skilled workers. It was strongly urged that these men, engineers especially, stick to their posts and not allow the lure of uniforms to divert them voluntarily from their tasks.

Along this same line, Zay Jeffries—chairman of the advisory committee on metals and minerals, National Academy of Sciences, in his remarks stressed the importance of conservation of manpower on the production front. At the top are the few thousand men in whose hands rests the planning of the entire war program. They must be conserved. Down through the ranks are the millions who watch over the machines that produce the goods. These people are human beings who, when worn out cannot be replaced or repaired like machines. They, too, must be conserved.

Zay Jeffries gave as clear an explanation of the conservation program as we have heard in a long time. He dug right down to the roots of the subject, discussed its elements and developed a general philosophy of conservation which is worthwhile to note. In brief it is this: *There is no better conservation program than an all-out war effort to end the conflict as soon as possible.* Paradoxically, such a conservation program uses up increasing amounts of materials to secure its end, therefore con-

(Continued on page 433)

VANADIUM STEELS



(J. G. Zimmerman, R. H. Aborn and E. C. Bain)

EFFECT OF VANADIUM UPON AUSTENITIC GRAIN SIZE AND DEPTH OF HARDENING OF CARBON TOOL STEEL

VANADIUM CORPORATION OF AMERICA • NEW YORK, N. Y.

serving within this all-out "conservation" program is necessary.

To do this, first, materials already formed into products must be conserved, such as production machinery. Tools, machines must be given high-grade maintenance to obtain their maximum use. Second, human beings must be conserved by utilizing the manpower according to training and ability, and by conserving their energy.

To be successful, the entire war effort must be properly balanced and timed. Balancing is all important. Industries and their material requirements must be balanced against needs; engine production must be in balance with the production of engine frames. Timing, too, is a critical factor. The production of each part of each unit must be timed for assembly without delay.

There is still another factor—the judicious use of available materials. Gillett's counsel to use each material where it does the most good is the goal to strive for. Cladding, plating and bi-metals were cited as some efficient uses of available materials.

Boosting Production

Speaking about the controlling factors in iron and steel production, Wilfred Sykes, president of Inland Steel, admittedly went way out on a limb when he predicted that the ceiling in steel production will be 98,000,000 tons and would be reached in 1944. This he implied, is one of those controversial figures that are speculative at best and which help little in the solution of the steel supply problem.

The significant point of his statement is that in the near future—probably by 1944—the practical maximum steel production, whether it be 90 or 98 million tons, will be reached with the use of the present and expanded facilities. After that, as Mr. Sykes pointed out, further expansion will have to start from scratch. New iron ore deposits as well as the other raw materials would have to be developed; new construction would be necessary from transportation facilities all along the line to steel fabricating and finishing equipment. Whether such a tremendous undertaking will be necessary depends upon the length of the war and the amount of steel needed to smash the Axis. Certain it is that steel made and used *now* is of far more value than the same amount available in 1944, but we're going to need every ton we can get in 1944, too.

Many of the less economic-minded members of the audience curled up for a period of surreptitious slumbering when Donald H. Wallace, assistant director of the Price Division of OPA arose to speak on prices as a factor in metal supplies. Those who feared it would be a high flight into theoretical economics were mistaken. Mr. Wallace spoke simply and practically on the price situation and explained many points that hitherto were not clearly understood by many engineers.

The most important part of his discussion was on the matter of price increase as an incentive to increased production. He gave three reasons why price increases do not necessarily generate a rise in the production of metals. First, elevating prices does not enlarge production significantly unless production is increased everywhere, unless labor cooperates and unless the government lends a hand and pushes the drive. Likewise, often the price advance is rendered useless by the dissipation of the increase through wage raises, profits, etc. And finally, price increases themselves start a cycle of instability through psychological reactions; inflation results which makes planning difficult and effects maximum production adversely.

And here is the distinguished panel of metal and mineral experts that discussed the metal-supply situation at the "Ores, Metals and the War" session. Left to right, Enoch Perkins, Zay Jeffries, Andrew Leith, John A. Church, Philip Wilson, D. H. Wallace, Paul Linz, Dewitt Smith, Charles Jackson, G. W. Roddewig and Gilbert Seil. At the moment McConnell is speaking and Wilfred Sykes and Clyde Williams, chairman of the session, are seated at a table just outside the picture.

Mr. Waliace cited the "premium price" plan as the soundest method of encouraging increases in production. By this plan producers are paid the regular price for the metals they produce in quantities up to their established quota. Over those amounts, higher or "premium prices" are paid. Thus the general price level remains stable, but marginal and high cost producers will be able, in important cases, to bring in additional metallurgical raw materials.

Non-Ferrous Metals

The non-ferrous metals copper, zinc, manganese, chromium and magnesium received prominent attention from three speakers at the session. The story on the magnesium situation was followed with much interest, for that metal now occupies the position that aluminum held less than a year ago—the hot spot of speculation and uncertainty, with reports of all sorts circulating about expansion plans and schemes. Philip D. Wilson, technical consultant with the WPB did much to clarify the situation.

Magnesium production, he stated, would be expanded a hundredfold to 191,000 tons planned for 1943. [Since then announcement has been made of plans for an ultimate total capacity of about 350,000 tons.] Three different basic methods of producing the metal will be employed to achieve this goal. One is by the electrolysis of molten magnesium salts obtained from either sea water or magnesium chloride brines; another by the Hansgirg process in which the electrothermic reduction of magnesium oxide by carbon is utilized; and third, by the ferro-silicon process, where calcined dolomite is the raw material and ferro-silicon the reducing agent.

The National Academy of Sciences investigated all the various ways of producing magnesium, and found the ferro-silicon process to be the best from several standpoints. The electrolytic methods are the most reliable, but require more time and much more power than the ferro-silicon method which, although relatively untried, is fast, uses less electric power and has a low cost of construction. One half of the present expansion will be for the ferro-silicon process, which is scheduled for completion by mid-summer. From this and everything else your editors hear, this process seems destined to be ultimately the No. 1 method for producing magnesium.

In summary Mr. Wilson divided the planned total magnesium production by the different methods as follows: 70 per cent by electrolytic processes; 20 per cent by the ferro-silicon method; 7 per cent by the Hansgirg process; and 3 per cent by experimental methods. [These proportions were based on the original estimate of 191,000 tons; what they will be for the new total of 350,000 tons we cannot say.]

To increase copper and zinc production, John A. Church, a consultant to the WPB, cited substitution, conservation and reclamation as the best means to that end. He implied that this was the quickest way to increase the production of these two metals

C'EST LA GUERRE!

The discussion following the formal "Ores, Metals and the War" session would have been a complete disappointment without the enlivenment of a spontaneous outburst from a somewhat discomposed prospector in the audience. Washington, he declared, had given him the runaround in his requests for aid in working an evidently fabulous zinc ore deposit that he had uncovered in New Jersey. The distinguished panel busily conferred a few moments, then explained the formidable and intricate series of steps the prospector should take before Washington would give him an official hearing. Unappeased or uncomprehending, the prospector finally suggested emphatically that "Washington come to see me!" C'est la guerre, indeed!

Announcing the

1ST WESTERN HEMISPHERE FOUNDRY CONGRESS

1ST WESTERN HEMISPHERE FOUNDRY CONGRESS
CLEVELAND, U.S.A. APRIL 20-24, 1942
held jointly with
46th ANNUAL CONVENTION of the
AMERICAN FOUNDRYMEN'S ASS'N.

To Promote Hemisphere Solidarity

As a step toward furthering the Government's Good Neighbor policies, Hemisphere Solidarity, and to further a united effort on the part of the foundry industries in all the Americas, a Western Hemisphere Foundry Congress will be staged in conjunction with the 46th Annual Convention of A.F.A.

Organized as a Common Defense effort, the murderous attack on PEARL HARBOR and Declaration of War with all Axis powers changes the program to an ALL-OUT effort of the Foundry Industry for increased production of WAR MATERIALS.

Therefore, the Congress, Convention and Show in Cleveland next April will be a Demonstration of the Foundry Industry's Contribution to, and support of, our President's pledges of "COMPLETE VICTORY."

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FOUNDRY and ALLIED INDUSTRIES SHOW } *Cleveland,* APRIL 20 - 24, 1942

since it would require one to three years to increase the supply by normal methods. The best deposits have been worked and mountains would virtually have to be moved to get at new deposits.

To conserve vital metals he remarked that regulating the supply *at the source* is the ideal method of limiting the metals to the industries where they are most needed, but, he added, this was very difficult to accomplish. But so are most worthwhile steps! To our minds, this is the only logical and effective method of allocation and is no more difficult to accomplish successfully than the alternative of cutting-off the use of materials further along the line. The War Production Board has already set up the Requirements Committee to do this job of controlling the supply of materials at the source (see METALS AND ALLOYS for Feb., 1942, p. 267).

Probably the most optimistic speaker of the forum was Andrew Leith, technical consultant, WPB, who discussed the status of manganese and chromium in the present emergency. He declared that there was enough chromium and manganese available if steel production remained as planned around 90 million tons. (He presumably does not agree with Mr. Sykes on what the maximum steel production will be.) By "enough," Mr. Leith meant a sufficient supply for essential military needs at the expense of less essential civilian production.

Plans are now under way, he indicated, to intensely work our low-grade ore deposits of manganese and chromium, and large-scale beneficiation methods will be employed on every deposit that is large enough to support it.

Steelmaking

Mars' backbone is made of steel, and the technology of steel making, however obtuse it may occasionally sound, is a major ingredient of war-making. Two of the papers on steelmaking were closely related to steel manufacturing as part of the technology of war.

Bessemer steelmaking, of increasing importance because of the scrap shortage, has been vastly improved in recent years through scientific control of the blowing operation, the photocell having replaced the human eye to determine the "end point." H. T. Bowman of Jones & Laughlin presented a paper, "Significance of the Bessemer End Point," in which specific attention is paid to the degree of metal oxidation and its effect on steel quality.

Degree of oxidation and temperature are generally listed as the two major factors to be controlled in the Bessemer process, with the emphasis usually on temperature. Bowman shows that temperature variation has a considerable effect on the degree of oxidation. Increase in temperature of the blown metal increases the solubility of iron oxide, with a corresponding decrease in manganese recovery.

In making free-cutting screw stock, overblowing—with increased contact between iron oxide and sulphur—promotes the formation of the oxysulphides on which enhanced machinability depends, although

J. Hunter Nead of Inland Steel Co. (right), outgoing Iron and Steel Division Chairman, seems relieved and happy to be transferring leadership of the division to his companion in this photo, Earle Smith, of Republic Steel Corp., new chairman.

it also involves sometimes extensive billet reconditioning later. Control of afterblow length at around 15-16 sec. under normal blowing conditions results in good machinability, internal soundness and better surface quality.

The simple and nearly foolproof manufacture of good quality free-cutting high-sulphur steel in the open-hearth may now be accomplished by a practice involving additions of sulphites to the molten steel, it was announced by E. L. Ramsey & L. G. Graper of Wisconsin Steel Works in their paper, "Some Observations on the Production and Use of Sulphite-Treated Steel."

Either anhydrous sodium sulphite or bisulphite may be added in the ladle or mold, with mold additions preferred. The resulting sulphide patches are present in a uniform, fine dispersion rather than as isolated particles. The machinability of the steel and tool life in cutting are reported to be greatly improved for that reason over other high-sulphur steels.

THE LITTLE MEN THAT AREN'T HERE

METALS AND ALLOYS *officially sends its regrets to these entirely photogenic gentlemen, with whose faces or forms we intended to illuminate these pages:*

Tracy Jarrett	John Johnston
Cyril Smith	R. F. Mehl
Paul Beck	Zay Jeffries
N. B. Pilling	F. N. Rhines
W. B. Price	P. D. Merica

All of them were informally photographed by a budding camerist among your editors, but for reasons still beyond his understanding, very few prints were actually obtained, and those that did "come out" are a compliment neither to the photographer nor his subjects.

Perhaps by next year he'll have mastered his synchronization. Anyway, the pictures that you do *see here were taken by Kenn Henderson, International Nickel Co. man whose hobby is our redemption this time.*

Hardenability of Steel

Interest in hardenability as a "property" of steel is at an all-time high, and for good reason. Metallurgical engineers are ruefully facing the fact that of all the characteristics of steel that are improved by adding alloys to it and impaired by lowering or eliminating the alloy content —as is now the necessary practice everywhere—hardenability is, in general, the most important. Of special and vital interest, therefore, are new steels or new steelmaking practices that provide high hardenability with relatively low alloy content, and new methods of appraising newly developed or even hypothetical low-alloy steels in this respect.

The advantages of small amounts (less than 0.007 per cent) of boron in markedly increasing the hardenability of fine-grained 0.40 per cent C steel was established by G. F. Comstock of Titanium Alloy Mfg. Co. in his paper, "Effects of Eight Complex Deoxidizers on Some 0.40 Per Cent Carbon Forging Steels."

His paper has already been reviewed in our Digest department (Feb. 1942, p. 292), so that we need only recall here that the improvement in hardenability traceable to the incorporation of boron in such steels as S.A.E. T-1340 and S.A.E. 3240 is accompanied by good ductility and superior toughness in the quenched-and-drawn steels, when drawn below 600 deg. F. Also it is better, from the physical property standpoint, Comstock declared, to add the boron in a complex titanium alloy such as manganese-silicon-titanium than in the form of ferro-boron.

What fireworks this might have set off will never be revealed (by us, anyway), for at least one doubtless interesting and evidently informative written discussion was 100 per cent censored—leaving its author, Mr. Comstock and the audience all quite chagrined. The paper did deserve a fuller discussion, however, for several reasons—it provided a natural springboard for examination of the general efficacy of boron additions in steelmaking, widely experimented with in recent months; and it should have started an impromptu forum on the several methods and agents now known to be helpful in boosting the hardenability of plain carbon and very low alloy steels.

But boron—and many other steel constituents—received a heavy share of attention during the Iron and Steel Division's "hardenability" session on Thursday afternoon, which was the occasion for the presentation of M. A. (Carnegie-Illinois) Grossman's important paper "Hardenability Calculated from Chemical Composition" (if you don't think we know an "important" paper when we hear one, just examine this list of metallurgical intelligentsia who discussed it: Austin, Bain, Comstock, Edson, French, Gillet, Harder, Hull, Mehl, Scott and Thum, plus a few others who got away!)

Grossman's paper told us so many currently highly useful and practical things about hardenability that we couldn't possibly set them all down on the paper allocated to us for this report. But here are a few:

(a) The hardenability of most steels

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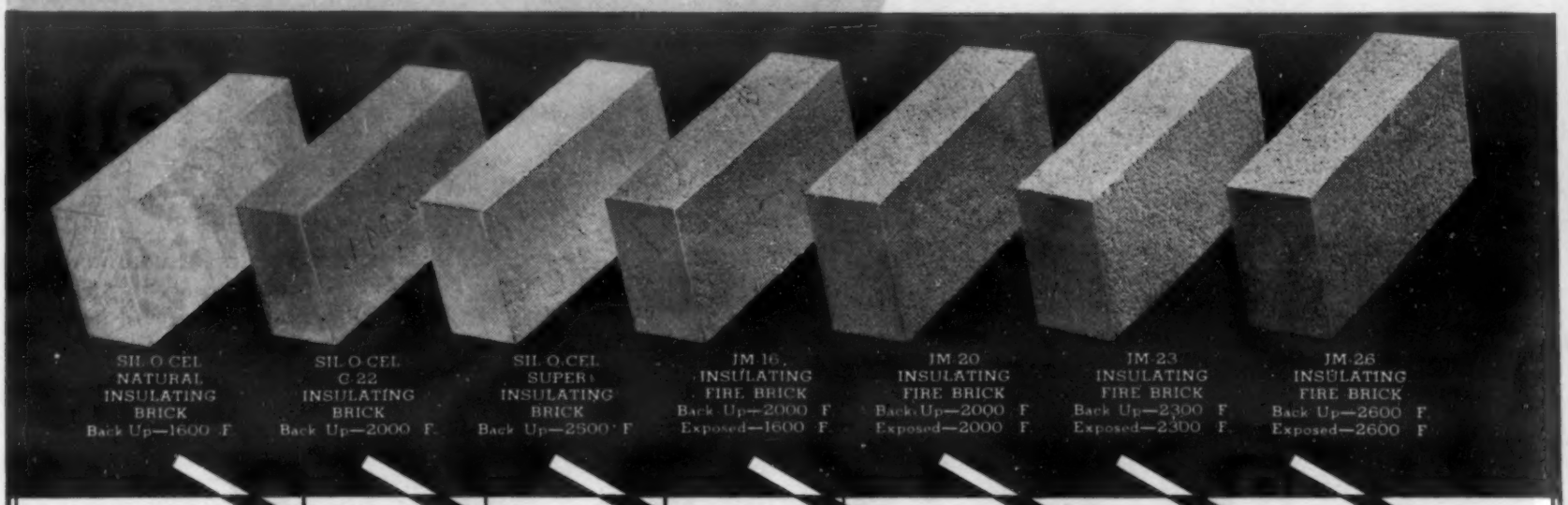
SIL-O-CEL NATURAL INSULATING BRICK Back Up—1600° F.
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Properties							
Density—lb. per cu. ft.	30	38	40	22	31	38	44
Transverse Strength—lb. per sq. in.	140	115	90	70	100	135	150
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	125	170	165
Linear Shrinkage—%	1.4 @ 1600° F	0.8 @ 2000° F	2.0 @ 2500° F	0.0 @ 2000° F	0.0 @ 2000° F	0.0 @ 2300° F	0.5 @ 2600° F
Reversible Thermal Expansion—Percent	0.1 @ 1600° F	0.7 @ 2000° F	1.29 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F
Conductivity at Mean Temperature	∥ ⊥						
500° F	1.01 .67	1.67	1.70	.75	1.01	1.26	1.61
1000° F	1.13 .79	1.88	1.95	1.01	1.19	1.49	1.90
1500° F	1.24 .90	2.08	2.19	1.41	1.49	2.05	2.61
2000° F	... ..	...	2.45	...	1.91	3.37	4.29
Recommended Service							
Back Up	1600° F	2000° F	2500° F	2000° F	2000° F	2300° F	2600° F
Exposed	....	....	....	1600° F	2000° F	2300° F	2600° F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note:—1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu. in. per hr. per sq. ft. deg. F. at the designated mean temperatures.
3. ∥—with heat flow parallel to brick strata.
⊥—with heat flow perpendicular to brick strata.

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can be predicted within 10-15 per cent if the *complete* chemical composition is known, along with the as-quenched grain size (assuming complete carbide solution).

(b) A specific "multiplying factor" can be assigned to each constituent present, and the "base hardenability" of the chemically-pure plain carbon steel multiplied by this factor to give the hardenability (in terms of Grossman & Asimow's "ideal critical diameter") of the carbon steel plus that constituent.

(c) When several added constituents are present, their multiplying factors are *multiplied* together and by the hardenability of the base steel to get the hardenability of the final steel.

(d) The first small addition of an element has a much more powerful percentage effect than an equal further addition when some is already present.

(e) The significant corollary to this is that, if two elements are equally effective, a greater hardenability will be obtained by using 0.5 per cent of each than by using 1.0 per cent of either of them alone. And several potent constituents present in a total of, say, 1 per cent are likely to have a much greater hardenability-hiking effect than a total of 1 per cent of just 2 of them.

(f) For each element the plots of multiplying factor *vs.* per cent of constituent present (employed to find the hardenability multiplier for a given analysis) are straight lines—*e.g.* the multiplying factor for 0.0 Mn is, of course, 1.00; for 0.60 per cent Mn it is 3.00; and for 1.20 Mn it is 5.00.

The plainest practical lesson here is, as a few people evidently knew already, that a very efficient (and now the most patriotic) way to achieve a given high hardenability is to incorporate very small (practically residual) amounts of each of several potent elements in the steel. Gentlemen, here is a cornerstone of your metallurgy of tomorrow—watch the structure that will arise thereon!

Some discussers had trouble in accepting the fact that statements (d) and (e) above were not contradictory to (f). As Grossman and Bain both pointed out, however, there is no question of such contradiction if we remember that *multiplying*, rather than *adding* factors are involved. Try it yourself:

For example, just assume that 0.20 per cent X and 0.20 per cent Y have about the same multiplying factor—around 1.5. Adding 0.20 X to an otherwise-plain carbon steel gives it a relative hardenability of 1.0 x 1.5 = 1.5. The straight line relationship noted in (f) shows that adding 0.20 per cent more X to give 0.40 per cent X in the steel leaves us with a multiplying factor of about 2, and the relative hardenability of the 0.40 per cent X steel is 1.0 x 2 = 2.

Now, if to the first 0.20 per cent X steel we add 0.20 per cent Y, we must *multiply* the multiplying factor (1.5) for this much Y by the multiplying factor (1.5) for the 0.20 per cent X already in the steel, and the calculated relative hardenability for the 0.20 X, 0.20 per cent Y steel would thus be about 2¼—noticeably larger than that of the 0.40 per cent X steel, which was about 2. Super-position of the hardenability effects of *several* elements on each other in this way would, it is evident, result in a very sizeable increase in hardenability as compared to the same total alloy percentage involving only one or two constituents.

When the multiplying factor *vs.* alloy content plots for all the elements studied are set up on the same graph, their relative potency, point for point, is in about the following decreasing order: Manganese, molybdenum, chromium, silicon and nickel. Not in this list are boron, shown to have a relatively terrific effect in view of the tiny amounts present in boron-treated steels, and vanadium, which when present to the extent of only 0.04 per cent increases hardenability as much as does 0.12 Mn, or 0.13 Mo, or 0.16 Cr, or 0.45 Si, or 1.10 per cent Ni. Some constituents, notably sulphur, *decrease* the hardenability, probably by combining with and removing from usefulness some potent hardenability-improving element (such as manganese, in the case of sulphur).

The quantitative effects of the "strong" elements titanium and zirconium have not yet been evaluated.

Time in Metallurgical Engineering

No better subject could have been chosen for Dr. John Johnston's Howe memorial lecture than "Time as a Factor in the Making and Treating of Steel." Plainly suggesting the shortness of our time and the consequent urgency of speed in metal-processing, Dr. Johnston, director of research for United States Steel Corp., reviewed in stimulating fashion the specific effects of time in blast furnace metallurgy, Bessemer practice, open-hearth refining, heating and heat treatment, and in such special phenomena as carburization and decarburization, creep, aging, surface effects, corrosion, etc.

The lecture contained several almost epigrammatic generalizations for all metallurgical engineers. For example, in practically all metal-producing and metal-treating reactions, *rates* are of vital importance, and the slowest reaction is the limiting reaction.

Thus, in the blast furnace, the amount of coke required is controlled by the reaction between iron oxide and carbon rather than by straightforward fuel requirements. Rapidly "diminishing returns" result in attempting to approach complete reduction of the iron oxide, because of the disproportionate increase in *time* required for the reducing gases to pass through each ore particle to its center and then out. That is why only very finely divided solid ore can ever even hope to compete with the blast furnace for iron manufacture.

THE CURSE OF DRINK

Nasty rumors having been circulated that the strain of recent months was about to drive some pillars of the profession to drink, Howard W. Haggard of Yale's Applied Physiology Laboratory was asked to speak at the annual Institute of Metals Division dinner on "Some Modern Problems of Alcohol." It turned out that Dr. Haggard was concerned with physiological problems, but you can imagine the six or eight lifted eyebrows and the couple of hundred sighs of relief that went up when he declared that it was physiologically harmless to "get tight" once in a while.

With him he had brought a remarkable machine that could accurately class an individual at any moment as being either sober, mellow or high-as-a-kite. R. M. Brick (also of Yale, please note) kindly consented to blow his breath into the contraption for demonstration purposes, and to everyone's surprise it registered "sober."

Typical instances of suffering a net loss of time through over-zealous efforts to save it are often encountered in ingot soaking pit practice. Frequently soaking time is insufficient to achieve thorough heating; again, the surface of an ingot is sometimes badly overheated in an attempt to shorten the soaking time by raising the temperature.

In attempting to establish heating conditions to achieve efficient but thorough annealing of, say, steel sheets, it should be remembered that the heat is mainly transferred *horizontally* along each sheet rather than vertically from one sheet to the next. In other words, the resistance to heat transfer at the surface is far greater than the resistance to heat flow of the steel itself—a point that is insufficiently considered by designers and manufacturers of heating equipment in general, Dr. Johnston declared.

Austenite grain growth, constant-temperature transformation, cooling of rail

Part of the head table at the Institute of Metals Division dinner. In the usual order: P. D. Merica, International Nickel Co.; F. N. Rhines, Carnegie Institute of Technology; Earle Smith, Republic Steel Corp.; Howard W. Haggard, Yale University; and D. K. Crampton, Chase Brass & Copper Co., retiring division chairman. Carl Swartz, of Cleveland Graphite Bronze Co. (just outside the field of this picture), is the new chairman of I. M. D.

steel, carburization and decarburization, strain-aging, the attainment of equilibrium in general, and other phenomena or processes were shown to be closely dependent on the time factor for the achievement of given effects or conditions.

Copper and Brass Fabrication

The high place of copper and brass in the war production effort was clearly demonstrated by the very large proportion of papers presented that dealt with those metals—and we are excluding, at that, the many theoretical papers that seemed to have little direct bearing on the immediate National task.

Of the *copper* papers presented, most controversy seemed to be centered on "Effect of Impurities on the Solubility of Sulphur Dioxide in Molten Copper," by Carl F. Floe & John Chipman of M.I.T. Much attention was paid to the question of the possible solubility of carbon in molten copper under certain conditions.

In the past, hydrogen has been singled out as the main culprit that caused all the trouble in copper castings. The practical significance of this paper is that the authors, through their investigation, stressed the possibility of carbon's being soluble in molten copper and that perhaps some of the defects in castings, such as blowholes, etc., are due to this cause.

Since carbon was assumed to be insoluble in molten copper in previous investigations, errors in measuring were experienced in arriving at the conclusion that the solubility of sulphur dioxide in molten copper was proportional to the square root of the pressure. This investigation modifies that conception and concludes that the system obeys the simple mass law.

Appropriately entitled "a classic" by S. Skowronski, chairman of the session at which it was presented, the paper by J. S. Smart & A. A. Smith, Jr. of American Smelting & Refining Co. on "The Effect of Iron, Cobalt and Nickel on Some Properties of High-Purity Copper" is the first and only investigation of the changes in conductivity and softening temperatures derived from specific additions of iron, cobalt or nickel to high-purity copper available to metallurgical engineers. Ten or 12 years ago a paper on this subject was inappropriately given before the American Chemical Society and now is buried in its journals.

Nickel, cobalt and iron behave similarly with respect to the softening temperature of oxygen-free copper (a very small effect up to 0.05 per cent impurity). However, their relative effects on resistivity or conductivity increase (in the direction of their displacement from copper in the periodic system) by the whole number ratio 1:5:9; in other words—the conductivity-reducing effect of iron, farthest from copper in the periodic table, is 9 times that of nickel, on an atomic per cent basis.

Production practice, rather than impurities, as affecting the properties of copper was investigated by W. M. Baldwin, Jr. of Chase Brass & Copper Co. in his paper "Effect of Rolling and Annealing Upon the Crystallography, Metallography and Physical Properties of Copper Strip."

Annealed copper strip is being employed today in lots of places that we're not permitted to mention here (but of which practically everyone knows), and the use of different production schedules in the different mills results in considerable variation in forming properties. Baldwin's paper was an attempt to reduce the processing variables to some rational pattern.

Pole figures and Erichsen cupping tests were employed to show how "earing" (protruberances around a drawn cup, usually 4 in number and symmetrically disposed with respect to the direction of rolling) is related to the degree of orientation in the copper strip. Strip containing even less than 60-70 per cent cubically aligned grains still can produce ears at 0 deg. and 90 deg. to the direction of rolling. This relation is more direct than any connection between ear-height and final annealing temperature, for instance, or ear-height and ready-to-finish annealing temperature, or ear-height and final reduction by cold-rolling, since variations among these factors can produce widely different percentages of cubically aligned grains in the final strip.

Brass

The earing of brass—an alloy that is used in this country *(shh!)* for cartridge cases—was examined by E. W. Palmer & C. S. Smith of American Brass Co. in their paper "Effect of Some Mill Variables on the Earing of Brass in Deep Drawing." A feature of this paper that places Palmer and Smith in line for our special award for getting - to - the-root-of-a-matter-let-the-chips-fall-where-they-may is their summary

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of the factors that have *no* effect on the development of earing.

Type of rolling mill, number of passes, reduction per pass, surface finish, impurities and casting directionality—popularly supposed to be of importance—are all actually without effect. The most important factors that *do* affect directionality (and, therefore, earing) are the amounts of reduction given to the metal between anneals and the temperatures of the various anneals.

At first, this seems hardly in agreement with the conclusions of Baldwin, above, with respect to earing in copper. However, Baldwin, in discounting any direct relation between earing and the final annealing temperature, was referring to the *height* of ears rather than the earing *tendency*. On the close relationship between earing tendency and processing factors, both sets of authors are in agreement. They also share the opinion that the interrelation of the various production factors—their effects on each other, for example—and earing is so complex as to seriously hamper prediction of the earing tendency that will follow a given processing schedule.

"Earing tendency" has become such an important factor in the production of deep drawing brass, Palmer and Smith point out, because of the recent introduction of the 4-high rolling mill for brass. With the new mills very heavy reductions between anneals are possible, except where earing tendency exists—in which case the really economical schedules that the 4-high mills should provide cannot be employed.

Two methods of utilizing the reduction capacity of the new mills while still avoiding ear formation are: (1) with common high brass, breaking up the directionality from a reduction of up to 22 B. & S. numbers by a high temperature anneal (1200 deg. F.) followed by a light reduction and a final anneal at lower than 1060 deg. F.; and (2) with 65-35 brass, dividing the total reduction required, even if up to 26 numbers, by a single, properly-placed anneal, and being sure the final anneal is not too high.

Still another attack on the earing problem in brass was reported by H. L. Burghoff of Chase Brass & Copper Co. in his paper "Directional Properties of 68-32 Brass Strip." Dozens of data on directionality and the occurrence of ears at intermediate processing stages, with special attention to the last and next-to-the-last rolling and annealing, were obtained.

Directionality (and, therefore, earing) caused by intermediate treatments can be reduced or eliminated by proper final treatments. Generally, earing tendency increases with degree of both next-to-the-last and final reductions, with decreasing next-to-the-last annealing temperature and with increasing final annealing temperature.

Brasses Containing Bismuth

Bismuth, one of the traditional "bad actors" of brass metallurgical engineering, was investigated as to how much of it really *could* be tolerated in brass without trouble, by W. B. Price & R. W. Bailey of Scovill Mfg. Co., in a much-discussed paper entitled "Bismuth—Its Effect on the Hot Working and Cold-Working Properties of Alpha and Alpha-Beta Brasses."

As a commentary on how these things work out, we note that the good effect originally sought—the inhibiting of dezincification of condenser-tube brass—was absent (in fact, bismuth *accelerated* dezincification); that the reported ability of brass, with appropriate "babying," to tolerate much higher amounts of bismuth than previously believed was not fully accepted by some of the discussers; and that an actual *beneficial* effect (on machinability) of bismuth additions was discovered.

The authors reported that in alloys containing up to 70 per cent Cu and 1 per cent Bi, "fire-cracking" due to bismuth may be avoided by a suitable processing schedule or by additions of 0.01-0.02 per cent P. Other brasses containing even up to 5 per cent Bi could be fabricated by a special technique, described in the paper.

The observation that bismuth (up to 1 per cent) improves the machinability of Muntz metal just about the way lead does is limited in applicability, since there is no advantage in discontinuing the use of lead in favor of bismuth. However, as Sam Tour suggested in the discussion, the machinability-improving feature may have real significance today if it is established that bismuth functions similarly in silicon bronzes, for example. At present, the silicon bronzes cannot be used for free-machining applications because lead is not a permissible part of their composition; if bismuth can be employed to confer high machinability, however, free-machining silicon bronzes can replace free-machining tin bronzes in many applications, and thus provide *some* relief for the tin situation.

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Equipment • Finishes • Materials • Methods • Processes • Products
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The Production Front

by H. R. Clauser
Assistant Editor

LAST month the gigantic task of converting our intricate highly-specialized peacetime industrial machine to war production was foremost in the minds of the men whose job it is to see that our distant front lines are supplied with the implements of war. Conversion of the automotive industry is already underway; the refrigerator, radio, washing machine and typewriter industries have either started or are ready to start; and small plants and shops are being given concentrated attention to enlist their total resources in the war effort.

Steel allocation continued to be a knotty problem, with increasing demands for plate calling for even stricter allocation control. With plate capacity just about reached, nothing more can be done until the projected plate mills are completed. Shot and bullet core steel have been put under complete allocation control. The railroads were promised a sizable allotment of steel, only to be cut short several weeks later by Army demands for shell steel.

Tin approached nearer to the top of the scarce metals list, and WPB took heed and speeded up construction of the Texas tin smelter. All sorts of rumors about the planned magnesium production were prevalent. A number of non-ferrous metals, particularly tungsten, chromium and cobalt, received further restrictions of their use, and plans were laid to uncover and collect all idle metal stocks in the hands of manufacturers. Several salvage campaigns were launched to recover an appreciable amount of the formerly wasted metals in this country.

The Conversion Task

Donald Nelson, WPB head, has singled out the next six months for an intensive drive to convert totally from peace to war production. These will be six critical months because the time required for the conversion has a direct bearing on the length of the war.

The conversion program must, primarily, convert two elements—machines and men. Men who have been skilled in producing typewriters, refrigerators, autos, etc., must modify their training to the new highly-skilled jobs in war implements' production. Machines producing peacetime products must be retooled, often rebuilt. Unfortunately, not all of industry's facilities are convertible to war work. In the automotive industry, 25 per cent of the equipment is highly specialized machinery and cannot be revamped for war production.

Last month came announcements of further conversion plans for the typewriter, refrigerator, washing machine, and radio industries. Typewriter production will be cut drastically, ultimately to over 50 per cent. The facilities will be used for the manufacture of small arms, ammunition, parts for aviation instruments, and many other small war items. Refrigerator production will be cut to almost nothing after April 30, and radio manufacturing, already cut to 40 per cent below last year's total, has been directed to go even further in changing from civilian radio production to the manufacture of vital war products, such as signal corps equipment and detection devices.

If, after 3 or 4 months, the conversion is not accomplished, steps will be taken to disperse the industry's facilities. Such action probably will not be necessary, but if so, it would represent a significant loss to our war production program.

Machine tools and other metal working equipment are extremely important to the success of the conversion program, and everything possible is being done to use the existing facilities most efficiently. Last month a telegraphic survey was made of the critical metal-working machines in the automotive industry and among about 150 manufacturers of parts and suppliers to the industry. The purpose of the survey was to obtain specific information on which to base the allocation of the machinery where it is best fitted.

Schedules for the delivery of machine tools have been advanced sharply, and WPB announced a comprehensive program to get maximum output. New producers are being sought; continued emphasis is being placed on the more extensive and effective use of the tools available.

A large part of the country's production capacity is in the thousands of small manufacturing plants and shops. Toward this group must be pointed a major part of the conversion effort. The Production Requirements Plan, mentioned here last month, is one aid towards helping the little fellow, and thus far it has proven very successful. A survey of machine tools in the country's plants by the Production Division of the WPB has put to work much metal-working equipment which would have otherwise been wasted. At the same time, more emphasis is being placed on subcontracting and pooling to convert and bring into action the total production resources of small business.

Steel

Is the available steel stock being allo-

(Continued on page 444)

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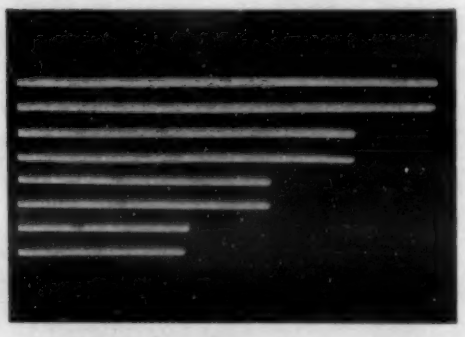

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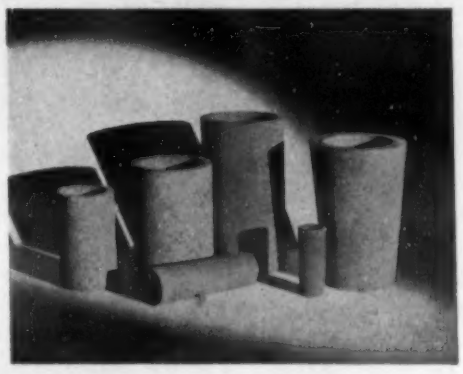

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cated to the places where it is needed most and is the rationing balanced? Questions like this were raised in many quarters last month, but there is no definite answer, except that there just isn't enough steel to go around. The incoming steel orders continue to exceed output, and the result is to further increase the backlog. Steel orders in many instances carrying A-4 to A-10 ratings are still placed on the waiting list with no definite information about when they might be filled.

It is possible that the Army-and-Navy-always-comes-first theory is not entirely justified in some instances. An example is the order for the allocation of 900,-530 tons of steel and 2,250 tons of copper to the railroads during the first quarter, but *only if* such allocation does not interfere with the requirements of these metals for shell production. That one condition could possibly side-track a major portion of the copper and steel allotment to the railroads and result in material impairment of our already heavily-taxed transportation system. It should be remembered that sufficient transportation facilities for transporting raw materials to fabricating points and finished war products toward the front lines are probably as important as the materiel itself. Late last month the 535,000 tons of steel assigned specifically for rails during the first quarter was already reduced one-half.

But the accurate allocation of the present plate production is a difficult problem, and the Iron and Steel Branch of the WPB is doing its best to meet all the most necessary requirements. By the end of March monthly plate shipments were expected to be well over 800,000 tons, which is about the limit of actual production at the present time.

In a move to assume a more rigid control of steel plate production, C. E. Adams, head of the Iron and Steel Branch, announced a comprehensive plan for control over production, allocation and consumption of steel plates. Under the plan, accurate information as to monthly requirement for steel plates will be correlated among producers, consumers, and government agencies; accurate information for government agencies as to consumption and inventories will be obtained; and more accurate and practical control over schedules and allocations will be developed.

Right now the big shortage is in wide plates, 90 in. and wider and more than ¾-in. thick. There are only 13 sheared plate mills, with a total capacity of 227,300 tons per month, that can produce the larger size plate. Construction is now under way to increase this capacity by 46,-000 tons and should be completed by the first part of 1943.

Complete allocation of shot and bullet core steel has been adopted in an attempt to halt surplus buying and to reduce excessive inventories of this type of steel. The order applies to steel for 20, 37, 40, 57 and 75-mm. and 3-in. armor piercing and semi-armor piercing shot, as well as to .30 and .50 caliber bullet cores.

Non-Ferrous Metals

All last month tin was the special worry of the War Production Board. As Japan struck deeper into the Dutch East Indies our tin, almost exclusively supplied from that part of the world, threatened to be cut off completely.

Work on the construction of a tin smelter in Texas was rushed towards completion with the granting of an A-1a rating for materials. Originally planned for 18,000 tons annually, the plant has been increased to 52,000 tons capacity, and it is very likely that this may be upped again. The plant will use chiefly Bolivian ore. Although the ore from this source is not sufficient alone to keep the plant going at peak capacity over a long period, there is enough ore on hand to fulfil the plant's requirements for some time.

But this plant, even when operating at the present planned capacity, can only furnish half of this country's normal tin requirements.

One of the major means of compensating for our lack of tin is through the drastic curtailment of its uses. Steps were taken to reduce the use of tin for cans 40 per cent under last year's total. This order alone will save 15,500 tons. The need of a substitute to use in place of "tin-less" cans has caused the adoption of a process known as Bonderizing, which should forestall any extreme shortage of cans at the present time.

Besides the tin can curtailment, WPB froze all tin and tin-bearing materials in the hands of manufacturing jewelers and made tinplate, terneplate and long ternes subject to the quota system.

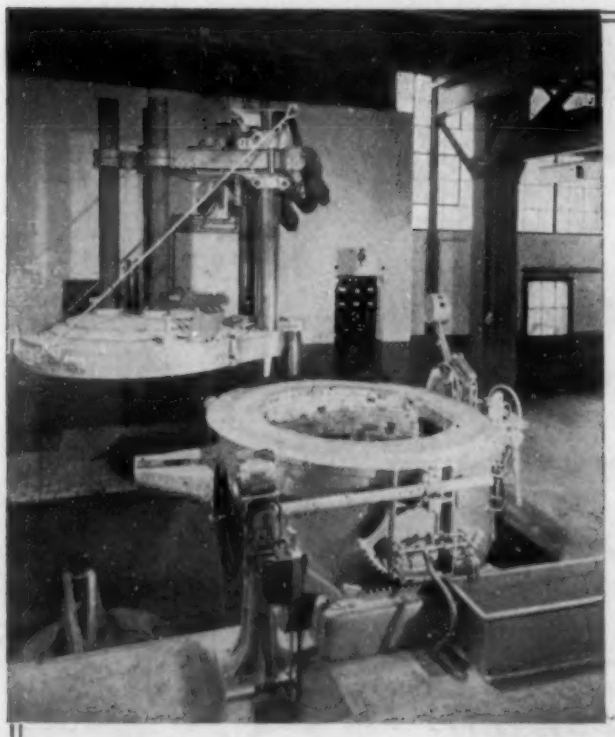
As various limitations and conservation orders were placed on such metals as copper and aluminum, large stocks already in the hands of manufacturers became idle. The Inventory and Requisitioning Section of WPB late last month indicated that an intensive program would be adopted to put into active use these critically needed materials, including semi-processed metals and finished parts. Aluminum was the first of the metals to be rounded up; a recovery of 20,000 tons is expected.

Speculation, well-founded and otherwise, about magnesium expansion plans was rife last month. Reports of projected expansion varied from 150,000 tons annual production to 350,000 tons. At this writing reliable reports indicate that there are definite plans for an annual production of 362,500 tons.

A large portion of the expansion will use the ferro-silicon process for the reduction of the raw material. This method has been found to be the most rapid to get into production, its cost of construction is low, it requires relatively little electric power, and is fast.

An interesting sidelight to the magnesium production picture was uncovered early last month when it was learned that Dr. Fritz J. Hansgirg, who developed the process used at the Permanente magnesium plant, was jailed by the FBI as a "dangerous enemy alien." In order to keep the plant running without any delays, he was connected with the plant by telephone to help direct production.

(Continued on page 446)



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DETROIT, MICH.
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Tightening of control over all nonferrous metals continued last month. The aluminum order was unified to bring into one order complete allocation control. Cobalt in all forms was placed under strict allocation control. Use of tungsten was further restricted by an order prohibiting its use in grinding wheels, gages and as a coloring material in some products after May 1. Chromium, already strictly controlled and on hand in sufficient quantities for present essential requirements, was placed under a complete allocations system. The policy right now is to build up reserves in preparation for any exigencies that might arise. Last month only 2/3 of available chromium was used in production. The rest went on the stockpile.

The possible use of zinc and brass die castings in the manufacture of artillery fuses in place of aluminum is receiving the serious attention of technical men connected with the die casting industry. Brass, steel, and zinc, all less critical than aluminum, are already being used in some fuses, and it is hoped that more extensive substitutions can be accomplished.

Scrap and Salvage

The Bureau of Industrial Conservation went after the scrap in auto graveyards last month and planned to clean them up in 90 days by making definite offers for the purchase of all jalopies in yards that are located within reasonable distance of points where the scrap can be used.

The principal consumers of iron and steel scrap are cooperating by aiding in the purchase and preparation of the scrap. Each company has appointed one man to be responsible for his company's participation in the program. Any junkyard that doesn't cooperate with the Government will have its contents requisitioned. As a double check, a "directory" of every automobile graveyard in the country is being prepared by the Bureau of Conservation.

If the estimates of the amount of potential scrap that is lying in auto graveyards is correct, and if the collection program is successful, then half of the steel scrap problem will be solved. But once the graveyards are completely exploited, the scrap from that source will become insignificant. With no new automobiles being manufactured, people will hang on to their old cars and refuse to bury them.

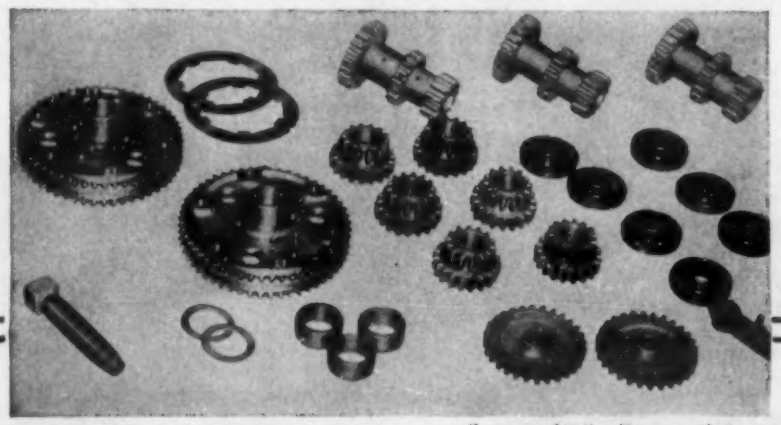
Of all the common everyday items that could be saved, people are most eager to save tin cans. But there are only a limited number of detinning plants, and so up until now, the Conservation Bureau has discouraged their salvage. However, experiments are being carried on with methods of reclaiming both the tin and steel from old cans.

Test campaigns are being conducted in Pittsburgh and Sewaren, N. J., where there are detinning plants, to determine the value of such salvage processes.

Plans were announced early in February for the construction of three plants in the Southwest, where cans will be prepared for a leaching process in the production of copper. The new plants will probably be completed by midsummer. By this proposed method the tin cans will be cleaned and shredded and the metal shipped to copper mines. At the mines, mine water containing copper sulphate, flowing over the shredded metal, will produce copper in an amount equal to the quantity of metal used. About 2,000 tons of copper per month will be produced by the mines using this process.

[*For additional interpretive news about metals in the war program, see the lively A.I.M.E. Report in this issue.*—The Editors.]

USE **AEROCARB*** ... FOR RAPID HARDENING, EASY CLEANING IN DEFENSE PRODUCTION



Courtesy of Indian Motorcycle Company

Economical AEROCARB carburizing materials produce rapid, uniform penetration in case depths from .002" to .030" in low carbon and medium alloy steels. Hardened parts are quickly and easily cleaned after an oil quench by washing in hot cleaning solution.

Uniform results in every heat are assured by using an AEROCARB A activator added at regular intervals to keep the molten bath in chemical balance. This constant balance, moreover, ends the waste and delays caused by "bailing out". Important, too, is the fact that drag-out losses can be kept to a minimum because of the exceptional fluidity of the AEROCARB bath. No expensive special equipment is required ... ordinary commercial pot furnaces can be used with the AEROCARB materials.

Write for full information on AEROCARB ... AEROCASE*... and other carburizing and case hardening compounds made by Cyanamid. Cyanamid field engineers will be glad to consult with you to help solve your case hardening and heat treating problems.

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Your Opinion Sought

"The Production Front," or its pre-Pearl Harbor predecessor "Defense Perspectives," has been appearing as a column in the Metallurgical Engineering News department since the October issue. So many favorable comments have reached us about this concise monthly interpretation of war production news for the metallurgical engineer that we're thinking of elevating it to the status of a full-fledged department all by itself.

What is your opinion? Do you read "The Production Front" regularly? Do you like it? Is it, in your estimation, important and interesting enough to warrant editorial presentation as a separate department?

Your answers will be our guide. Let's have them! —The Editors

Recently Developed Materials

Materials of special interest to the metallurgical engineer in the metal producing and fabricating industries are being introduced constantly. The war program with its tremendous demand for all types of materials has given added impetus to the development of new materials not only as additions to the war effort but as substitute materials in civilian production. Listed below are just a few of the many materials introduced recently. [*See the Jan. issue of Metals and Alloys for complete table of new materials for product design.*]

Forgeable Bearing Metal

The Mueller Brass Co., Port Huron, Mich., has developed a unique bearing bronze that can be forged or drawn, and yet possesses very good bearing qualities. Since it can be either forged or drawn, this alloy can be fabricated in a variety of sizes and shapes, and is readily adaptable for fabrication in all the modern automatic machines.

The alloy, known as "600" bearing metal, can be used where corrosion of bearings is a distinct problem, and is especially useful where extreme pressure lubricants, which contain a very high percentage of sulphur, are employed.

In the form of forgings or parts made from drawn rod, the new bearing alloy is said to have a tensile strength two or three times greater than cast bearing bronzes. It varies from 80,000-90,000 lbs. per sq. in. in forgings to 90,000-105,000 lbs. per sq. in. in cold drawn rods.

Some of its recommended uses are for gears, spindles, bushings, bearing pins, connecting rods, cams and drive shafts.

Metal Cleaning Solution

A new rust-proofing and metal cleaning solution, designated as "Ruscat," has recently been developed by the research laboratories of *The United States Stoneware Co.* of Akron, Ohio. Its principal use is for the cleaning and preparation of metal surfaces before the application of corrosion-resistant paints and coatings and also for the purpose of preventing further rust formation.

The use of the solution produces a mild etch over metal surfaces, resulting in the development of a chemically adherent inorganic base over which the lacquers and coatings are made to gain their maximum adhesion. A chemical cleaning of the minute pores of the metal is achieved along with the removal of all surface contamination, scale and rust.

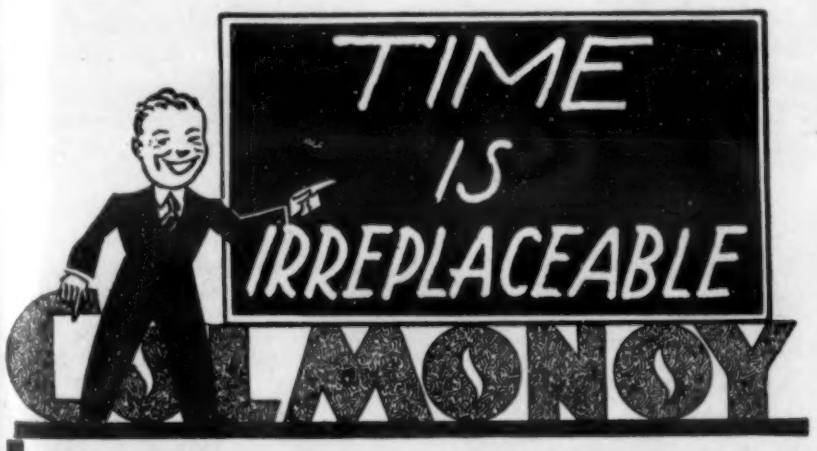
It can also be used to facilitate the handling of iron or steel after long exposure, storage and handling, prior to being used for fabrication.

The solution may be applied by brushing or dipping, and after a few minutes the solution may be wiped off and allowed to dry.

Water Emulsion Metal Cleaning

A water soluble concentrate, Macosol (formerly Solvtex W), is designed specifically for the removal of oil and grease from metal surfaces using a water emulsion. It is being marketed by *MacDermid, Inc.,* Waterbury, Conn. The compound is neutral in character and may be used on aluminum or magnesium without attack on these metals.

In ordinary applications the recommendations for use in cleaning are to use 10 per cent by volume of Macosol in water at a temperature of 160-180 deg. F. For heavy duty applications where chunks of grease and other materials which are difficult to remove are present, it may be necessary to increase the concentration to 20-25 per cent. For the heaviest duty such as the removal of carbon and similar deposits the concentration may be as high as 50 per cent in water. Following the cleaning bath the work should be rinsed in two hot water rinses, or if these are not

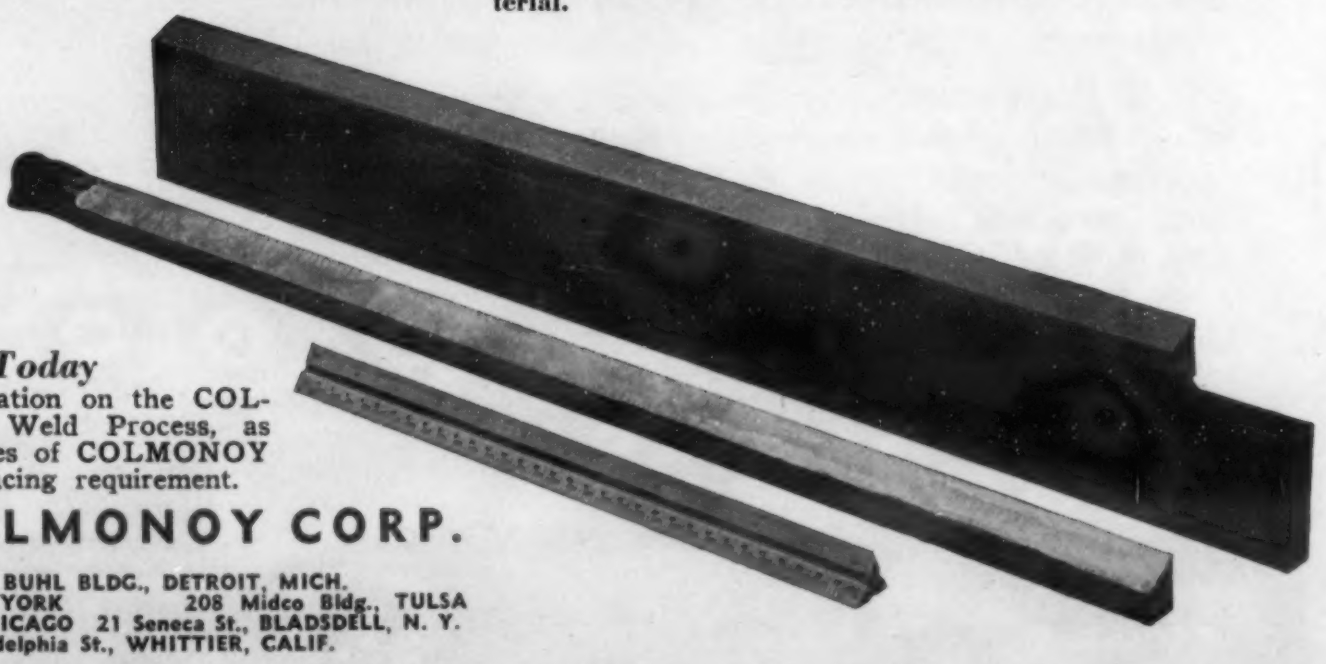


COLMONOY FURNACE WELDING

This process consists of applying a casting of COLMONOY No. 6 hard-surfacing alloy to steel base parts that are subject to corrosion, abrasion, wear and galling. Some of the advantages of this process are:

1. It is adaptable to high production parts.
2. There is complete freedom from porosity and cracks.
3. Parts can be hard-faced which are inaccessible for acetylene torch application.
4. Finishing requires the removal of considerably less material.

Use COLMONOY No. 6 lathe points, dogs, chip breakers, drill flutes, wire straightening shoes, thrust bearings, screw machine fingers, forming and drawing edges, etc.



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Ask for full information on the COLMONOY Furnace Weld Process, as well as all the grades of COLMONOY for every hard surfacing requirement.

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123 W. Philadelphia St., WHITTIER, CALIF.

available cold water sprays reaching every part of the articles are satisfactory.

A special application is as a rust-proofing compound for iron or steel parts which are ground or machined dry or with kerosene and are subject to rusting. An emulsion of Macosol containing 3-5 per cent by volume is used for this purpose. Best results are obtained by using the emulsion hot in order that the parts may dry free from water leaving only a thin oily film which will not harden. This film may be easily removed at any subsequent time by merely rinsing in water as previously described for procedure following the cleaning operation.

Other applications include the use as a cleaner prior to rust-proofing processes and the use to clean and rust-proof steel parts from which the cutting oil must be removed for inspection.

Porcelain Material as a Substitute

For use as a substitute for some metals high on the priority list a porcelain material known as Prestite, is suitable for many applications, according to *Westinghouse Electric and Manufacturing Co.*, East Pittsburgh, Pa.

It is a radically new and different kind of porcelain and is said to combine the best qualities of wet and dry process porcelain without the disadvantages of either. It can be pressure-molded into intricate shapes and lends itself to low cost quantity production; tolerances are guaranteed not to exceed 1/64 in. per in. regardless of size.

New Drying Agent

A new granular drying agent for gases and liquids, named Florite Desiccant, has recently been placed on the market by the *Floridin Company,* Warren, Pa. Florite Desiccant is satisfactory in a variety of industrial processes requiring bone dry gases and liquids, and has proved economical as well in many installations where high drying efficiency is not ordinarily demanded. Among the products now being dehydrated are natural gas, propane, gasoline, air, nitrogen, and carbon dioxide.

The outstanding characteristic of Florite Desiccant is its ability to maintain a high drying efficiency. It is reported to adsorb water instantly and will not swell, disintegrate, or appear wet at the end of an adsorption cycle. It is hard, stable, non-corrosive and non-poisonous.

Rust Inhibitor for Black Iron

Watson-Standard Co., Pittsburgh, Pa., announces the development of a new organic coating for black iron which, they claim, can be applied very economically at the steel mill and will result in the solution of many of the coating man's problems. This is used as a protective coating in lieu of the oil previously used on the metal.

The new product is of the oxidizing type. It is reported to provide exceptionally fine protection against corrosion, and serves as a prime coat for all types of synthetic and oleo-resinous coatings.

New Alloy for Collapsible Tubes

The impending shortage of tin and other vital metals and alloys formerly used in the manufacture of collapsible tubes caused the *New England Collapsible Tube Co.* New London, Conn., to seek a satisfactory alternate.

They have recently announced the development of a successful formula in which less critical methods are employed. The newly-developed material has been named "Sheffalloy".

Based upon complete tests, the alloy is reported to be an excellent alternative for metals normally used in the manufacture of collapsible tubes, and is said to have all the characteristics of appearance, pliability and strength of the regular tube material.

Direct-Fired Annealing Furnace

A new type direct-fired annealing furnace, which continuously anneals stainless steel strip, has been designed and manufactured by the *Selas Company,* Philadelphia. It is a catenary-type furnace and operates up to a maximum temperature of 2,100 deg. F. with a capacity of 1,250 lbs. of strip per hour.

The heating chamber of the furnace is 20 ft. long and 48 in. wide. The burners, 28 in all, located on both sides of the furnace, are direct-firing of the refractory screen type which provide rapid and complete combustion. It is estimated that a fuel saving of 20 to 25 per cent is possible with the use of direct-fire burners instead of the muffle type arrangement.

JESSOP C.N.S.

HIGH CARBON-HIGH CHROME DIE STEEL

Conserves
- MATERIALS
- MACHINES
- MAN HOURS

FOR WAR TIME PRODUCTION

The high wear resistance of Jessop C. N. S. die steel results in more pieces per grind of die, and its deep hardening characteristics permit more grinds per die. The increased production from C. N. S. saves die steel, reduces die setup and maintenance time, conserves the time of die makers, and lessens the burden on die making machines and grinding equipment.

War time economy demands the greatest possible production from men, materials, and machines. Jessop C. N. S. High Carbon-High Chromium Die Steel fulfills this need. Write for descriptive folder (Bulletin 441).

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CARBON · HIGH SPEED · SPECIAL ALLOY · STAINLESS · COMPOSITE STEELS

High Frequency Heating for Brazing

A new high frequency self-contained brazing unit applicable to bomb production has been announced by the *Ajax Electrothermic Corp.*, Trenton, N. J. The unit has a capacity of 75 two-lb. bombs per hour.

After the surfaces are prepared, a ring of brazing compound is placed in position, the assembly heated by placing it inside the induction ring, and then the parts are brazed. The heat is localized resulting in a sound, uniform joint. It is reported that the time needed is one-third of that required for welding.

For greater quantity production, small high frequency generators are used. For example, a 50 kw. high frequency generator and inductors and controls will braze 1,200 two-lb. bombs per hour, or will braze the adapters on 155 or 105 mm. chemical shells at the rate of 5 per min.

The high frequency equipment is convertible to other forms of brazing, to melting alloys, sintering carbide tools, or experimental heats.

Tools for Interrupted Machining Operations

The McKenna Metals Company, Latrobe, Pa., has announced new styles of "Kennametal"-tipped tools designed for interrupted cutting of steel castings and forgings in lathes, boring mills, shapers, and planers to speed up production in machining armor plate, tank parts, and other irregular shapes of steel castings and forgings. The new style tools with a negative shear angle of 35 deg. combined with a positive side rake of 15 deg. are said to permit the same economy in machining irregular sections as has been realized hitherto in simpler jobs cut with "Kennametal."

The principle of these new tools is that the interruption on the work first strikes the tool at a place back of the extreme point, where the cutting edge is mechanically strong, and then shears off the chip with a progressive action.

Slants and Plants

Three new furnaces just completed at *Oliver Iron and Steel Corp.*, Pittsburgh, will enlarge their capacity for heat treated high carbon steel and common black bolts by approximately 240,000 pieces per day.

During the past year the *Ironton Fire Brick Co.*, Ironton, Ohio, has greatly increased their productive capacity and has made a number of improvements in their plant. A large extension was built to the special shape department and a new drying system installed. New bins, a Clearfield mixer, and a conveyor system have been added and changes made in the tunnel dryers.

The latest in a series of conservation moves instituted during the past year by the *Allegheny Ludlum Steel Corp.*, Pittsburgh, has been the creation of a new scrap and salvage department. The new department was organized to handle all scrap for re-melting, and all other salvageable material for any purpose.

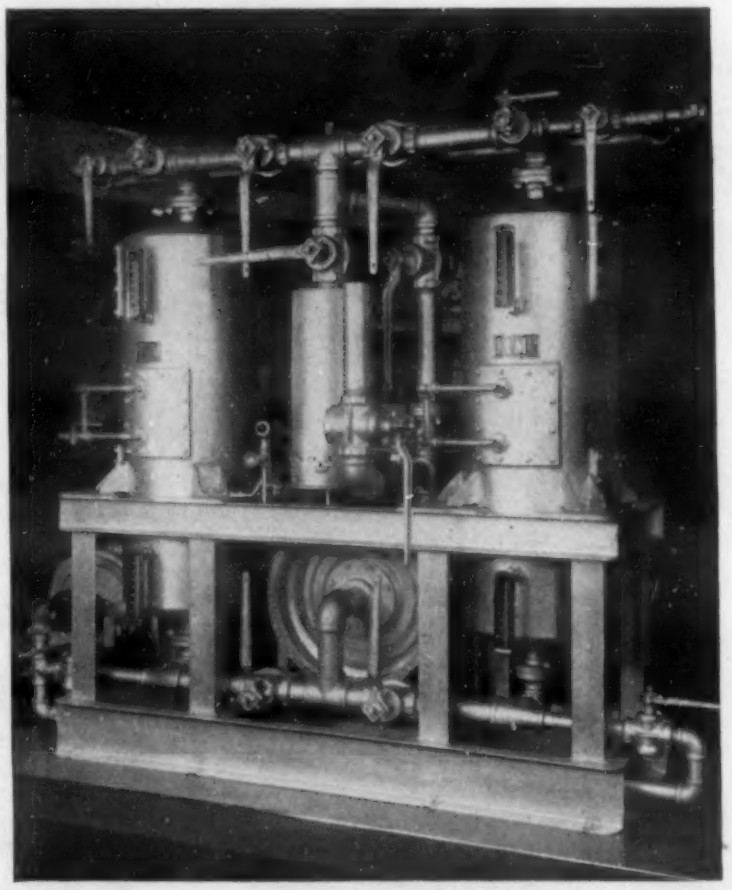
Inland Steel Co., Chicago, has begun installation of an electrolytic tin coating plant. The new units will take care of the tin-plating of about 2,000,000 base boxes of tin-plate per year. The new electrolytic process produces an even coating of tin and is being installed to help overcome the threatened shortage of this metal.

In addition, as an aid in conserving tin, the company has contracted with the *Wean Engineering Co.*, Warren, Ohio, for the manufacture of a Bonderizing line for black plate for use in the canning industry. Can manufacturers expect to be able to use a considerable quantity of Bonderized black plate coated with protective lacquer as a substitute for tin-plate.

One of the largest foundries in the world will be built by the *Buick Motor Co.*, Flint, Mich. It is planned to supply the company with aircraft engine castings and will cost $10,000,000.

Three additional electrolytic tin-plating production lines and six supplemental production lines for chemically treating black plate will be built by the *United States Steel Corp.*, Pittsburgh. The expansion project will cost $5,500,000.

Conversion of the *Great Lakes Steel Corp.'s* 96-inch continuous hot mill at Ecorse, Mich., to steel plate production has recently been completed. Only 6 mos. were required against 18 mos. that would have been needed to build new facilities for the purpose.



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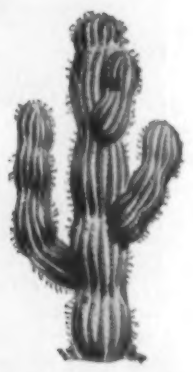


DRY

ANNEALING ATMOSPHERES

KEMP SILICA GEL DEHYDRATORS guarantee the *exact* degree of dryness you need in *your* annealing atmospheres.

Designed by gas equipment engineers; and proven by an impressive record of dependable and economical operation in plants demanding constant and exact drying of annealing atmospheres.

Write **The C. M. Kemp Mfg. Company, 405 East Oliver Street, Baltimore, Maryland—ask for Dryer Bulletin.**

STANDARD UNITS BUILT TO GIVE:
Capacities: 10 to 100,000 c.f.m.
Pressures: Atmospheric to 2500 lbs. per square inch
Adsorbent: Silica Gel, high capacity, long life
Activation: By gas, electricity, or steam, as desired
Types: Single or twin towers for intermittent or continuous operation

KEMP of BALTIMORE

Hardness Tester

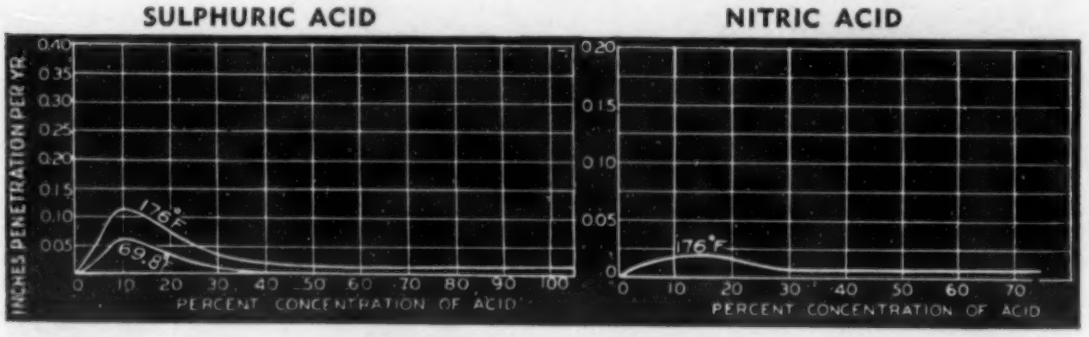
A hardness tester for testing metals and alloys and which was engineered with the thought of designing a penetrating instrument that would have the necessary provision for maintenance, and to have certain adjustments to maintain its accuracy, has been announced by *Clark Instrument, Inc.*, Dearborn, Mich.

The instrument is calibrated on the standard scale of 150 kg. major load and 10 kg. minor load. The 150 kg. load consists of 3 separate weights calibrated 50 kg., 40 kg., and 60 kg., thus forming a combination that will take in the standard hardness readings either direct or conversions.

The dial indicator has the standard dial numerals exactly the same as other penetrating instruments of this type. The tripping lever has been so arranged as to trip free from the main beam allowing the main beam to follow through without any friction from this source. For this reason, it is reported, quicker readings are possible.

For servicing the tester, it is not necessary to take it apart as all the adjustments are on the outside of the instrument. The elevating screw is 1-11/16 in. in diameter with a 4 pitch acme thread, making it so that fixtures used on other testers

of this type can be interchanged and used on this instrument.



Action of acids, various concentrations, on Duriron, 8 hours test. Agitated solutions.

DURIRON TECHNICAL DATA SHEET

DAYTON, OHIO

Duriron is more universally used than any other corrosion-resistant alloy. The following data should be clipped and filed for ready reference:

COMPOSITION	Essential nominal chemical composition, per cent ...Fe; Si 14.5; Mn, C, P, S, each less than 1%
PHYSICAL CHARACTERISTICS	Specific gravity 7.0
	Weight, lbs. per cu. in. ..... .255
	Melting Point, degrees F. 2300
	Electrical Resistivity, Microhms per Cm^3, 0°C. 63
	Thermal Conductivity (Ag-1) 0°C. 0.125
	Rockwell C. 52
	Tensile Strength (½" diam. bar) ....16,000 lbs. sq. in.
	Coefficient of Expansion:
	(32-212 deg. F.) 0.0000036
	(32-2300 deg. F.) 0.0000156
	Form available ..... Cast
	Method of Fabrication ..... Welding
	Machineability .....By grinding only
	Design .....Similar to Cast Iron
PRODUCTS AVAILABLE	Pumps, valves, pipe and fittings, kettles, tanks, exhaust fans, jets, ejectors, heat exchangers, laboratory equipment, etc.
RESISTANCE	To Sulphuric acid, all concentrations and temperatures, except 104%
	To Nitric acid, all concentrations and temperatures
	To Acetic acid, all concentrations and temperatures
	To Phosphoric acid, all concentrations and temperatures, except in presence of hydrofluoric
	To 5% Hydrochloric acid, all temperatures
	To Heat, good. Sudden temperature changes to be avoided
	To Abrasion, excellent
APPLICATIONS	Wherever corrosive liquids, wastes or gases are handled—in fine and heavy chemical manufacture, explosive manufacture, petroleum refining, etc.

Technical Data on DURICHLOR next month

THE DURIRON COMPANY INC. DAYTON OHIO · DURIRON · DURICHLOR · DURIMET · DURCO STAINLESS STEELS · CORROSION-RESISTING DURCO ALLOYS & EQUIPMENT THE DURIRON CO. INC. DAYTON, OHIO

Machine for Checking Spiral Gear Leads

Designed to check right- and left-hand spiral gear leads from zero to infinity, a new lead checking machine has been announced by *Michigan Tool Co.*, Detroit, Mich., as an addition to its line of gear checking equipment.

Of the adjustable sine-bar type, the new machine eliminates any need for master rolls, discs or lead screws in checking gears, and can be used with the Michigan gear checking recorder if desired. Gear-size capacity of the standard machine is 0-18 in. diameter, with distance between centers of 24 in.

The machine is of the horizontal type, designed for maximum rigidity to obtain utmost accuracy. It consists primarily of 2 "tables", a transverse table enclosed in the left end of the machine, which carries the sine-bar, and a longitudinal indicator table, which carries the indicator. The sine-bar table is arranged to reciprocate crosswise of the machine, while the longitudinal table moves lengthwise, paralleling the face of the gear to be checked.

● With all-out effort to conserve tin, the uses of a hardener, known as PMG, are being expanded, according to *Phelps Dodge Copper Products Corp.*, New York. The hardener is used in place of tin in the production of bronze castings, some of which in the past have contained as much as 10 per cent tin.

Refining Agents for Casting

Foundry Service, Inc., New York, is marketing a line of refining agents designed to remove troublesome oxides from a number of casting alloys. Aluminum oxides often cause porosity, low strength, brittleness, etc. in copper or nickel base alloy castings.

The refining agent, known as "Foseco Albral", removes this oxide by covering the alloys while melting and prevents the adsorption of gas and the formation of oxide. It also removes any oxides that may be already present from the alloying process, and improves casting and physical properties.

Electronic Arc Welder

A new low-current welding machine for welding light-weight, intricate work has been developed by *Allis-Chalmers Mfg. Co.*, Milwaukee. The machine is

said to be capable of welding sheets as thin as 32-gage in a wide variety of materials, including stainless steel, Monel, aluminum, copper, brass, lead and galvanized iron.

The accompanying photograph shows the "Weld-O-Tron" in use in an aircraft plant. The machine has a 6-tube mercury-vapor polyphase rectifier, and uses hot-cathode tubes with grid control. The control circuit is designed to give a constant current characteristic at all values of current setting, which makes the arc easy to start and hold and maintain optimum heat conditions at the weld.

Thickness and Thread Gages

Two precision measuring instruments have been recently announced by *Federal Products Corp.*, Providence, R. I. The one is a pitch diameter gage useful for inspecting pitch diameters of all kinds of threads, and is suited to British threads as well as those of United States' standards. The results are said to be equal to those obtained by the 3-wire method of measuring used so extensively in checking the accuracy of threaded plug gages and other precision screw threads.

The other precision instrument announced is a portable thickness gage specially designed for checking the wall thickness of 500-lb. demolition bombs. The same type gage is available for bombs of other sizes.

Bonderizing for Tin Cans

The Parker Rust-Proof Co., Detroit, has announced the release for industrial use of a process for the replacement of tin in the treatment of steel sheets from which cans and other thin metal containers and closures are made. Already several steel companies and one manufacturer, who annually produces millions of bottle caps, are making installations of the production equipment necessary for use of the new product.

Production capacity of equipment now on order is estimated at 10,500,000 base boxes annually. A base box is 217.8 sq. ft. of sheet. The adoption of the new development will release several thousand long tons of tin for more vital war production.

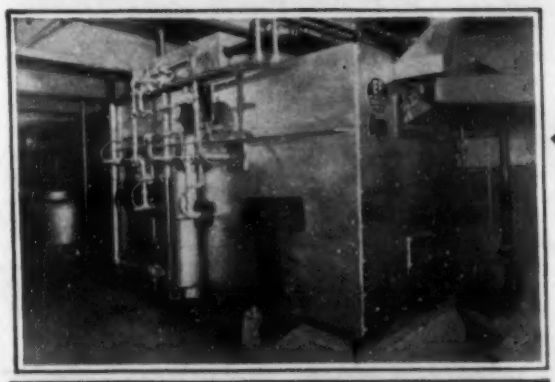
The new product, known as Bonderite "K", involves a new technique in application giving high-speed production. Instead of dipping or spraying, the steel sheets pass through all operations, Bonderizing, rinsing and drying, on a series of rubber rollers with the dual capacity of conveyors and applicators. Handling is entirely automatic from feeding to packing the finished sheet.

The new compound, as applied, produces a fine-grained phosphate coating, providing a rust-inhibiting steel "black plate", which, when lacquered or enameled, is successfully used in bending, drawing, crimping, lock-seaming and other forming operations, without serious loss of finish adhesion or effectiveness.

With these qualities, the new Bonderizing is applicable for treatment of black plate for use in the manufacture of cans, bottle caps and a wide variety of containers.

EF FURNACES

For Every Industrial Heat Treating Process



A Few National Defense Installations are Shown Below

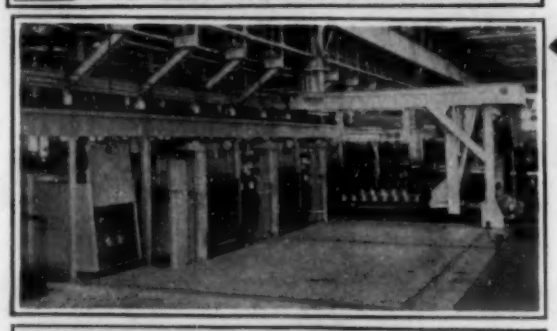
Machine Gun Cartridge Clips

Machine gun cartridge clips are heat treated uniformly, continuously, and scale-free in this E.F. special atmosphere continuous chain belt conveyor type furnace —one of a number we build adapted to heat treating arms and ammunition components.

EF

Aircraft Engine Parts

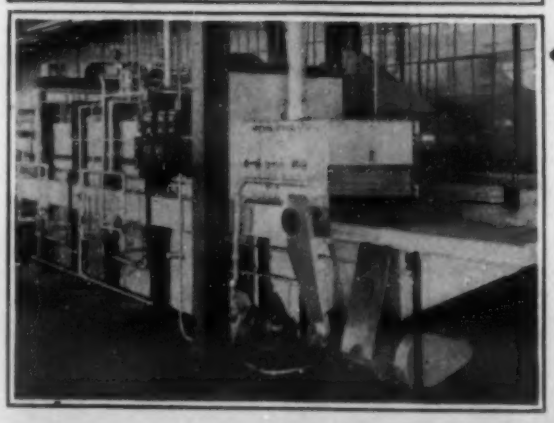
Aircraft engine parts are nitrided in this battery of double-ended reciprocating type furnaces—part of the world's largest nitriding furnace installation. Built by E.F. engineers and installed in a prominent aircraft engine plant.



EF

Brass for Cartridges

Brass for cartridges and other products are uniformly treated in various types of E.F. furnaces. This installation shows 3 gas-fired, hearth type forced circulation furnaces with quench, cooling chamber and handling crane —one of several installations in prominent non-ferrous plants.



EF

Annealing Shells

Designed for annealing brass shells, this E.F. gas-fired continuous roller hearth furnace is also adapted to treating steel shells. Large shells are carried direct on rollers—smaller shells are loaded into pans or trays.

We Build Furnaces for Annealing, Hardening, Forging, Brazing, Nitriding, Normalizing, Billet Heating and every other Heating or Heat Treating Process.—We Solicit Your Inquiries.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces—For Any Process, Product or Production

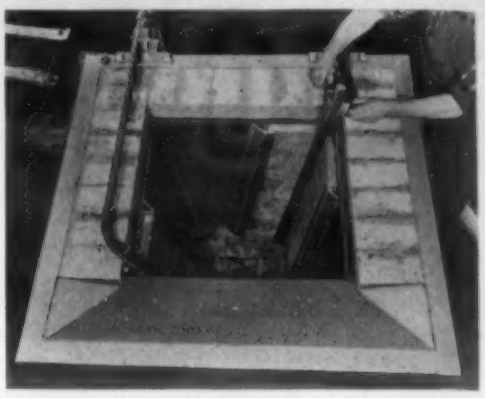
New Salt Bath Pot

An improved design change in the method of insulating pots for electric salt bath furnaces which has resulted in a decrease in the amount of bricks required, a reduction in maintenance, and an increase in working space, is announced by *Upton Electric Furnace Div.*, Detroit.

The new pot is designed for low temperatures and does not require brick insulating except at the corners where the electrodes are placed. Thus, instead of lining the entire surface of the floor and walls of the pot with bricks, only the floor and the space immediately behind the electrodes requires the insulating material. To keep the bricks in position, angle iron with a bracer strip, both of which are arc welded to the walls of the pot, hold the bricks in position. Sufficient space between the bricks and the angle is provided to allow for expansion under the elevated operating temperatures.

When the bricks are to be renewed, it is only necessary to slide them out at the top and replace the new bricking in the same manner, thereby saving the time and the material that would otherwise be required to brick the entire surface of the four walls.

Another feature is the ease of handling electrodes. A single bolt connects each electrode with its respective water-cooled



bus bar, permitting either electrode to be changed in dependently of the other without mechanical means.

Temperature-Indicating Sticks

Tempil Corp., New York, has announced a new form of their product, called Tempilstik°. These temperature indicators have a specified melting point and are available from 125 deg. F. to 1600 deg. F., in convenient temperature intervals, and are said to have a mean accuracy of within 1 per cent of the temperature stamped on each stick or pellet. For example, a 300 Tempilstik° drawn across a surface heated to less than 300 deg. F. will leave a chalk-like mark, which melts sharply into a liquid streak when the surface reaches 300 deg. F.

This method of temperature determination provides a simple and convenient method of signalling desired preheating temperatures in the welding of steel, special alloys, cast iron and non-ferrous metals; in local heating, heat-treatment and fabrication of metals generally, which require careful and accurate temperature control. They are particularly useful in the black-heat range, where the importance of accurate control is becoming increasingly recognized.

Meetings and Expositions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Houston, Tex. Mar. 23-25, 1942.

ELECTROCHEMICAL SOCIETY, spring meeting. Nashville, Tenn. Apr. 15-18, 1942.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, open hearth conference. Cincinnati, Ohio. Apr. 16-17, 1942.

NATIONAL PETROLEUM ASSOCIATION, semi-annual meeting. Cleveland, Ohio. Apr. 16-17, 1942.

AMERICAN CERAMIC SOCIETY. Cincinnati, Ohio. Apr. 19-25, 1942.

AMERICAN FOUNDRYMEN'S ASSOCIATION, annual convention. Cleveland, Ohio. Apr. 20-24, 1942.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, semi-annual meeting. Boston, Mass. May 11-13, 1942.

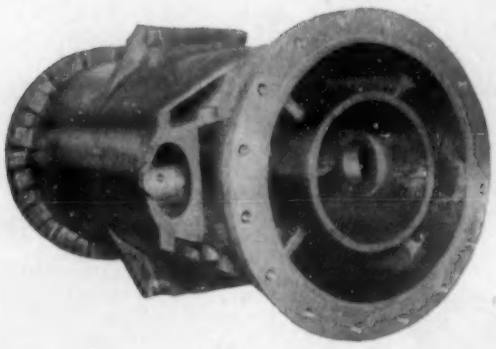
SOCIETY OF AUTOMOTIVE ENGINEERS, semi-annual meeting. White Sulphur Springs, W. Va. May 31-June 5, 1942.

DURALOY

CHROME IRON CHROME NICKEL CASTINGS

SKILL *and* FACILITIES

for Producing these Castings ranging in size



from A POUND *or even less*

to SEVERAL TONS

IT TAKES as much if not more skill to run a heat of high alloy steel, prepare the molds, and then make sound castings weighing around a pound or so as it does to produce a single casting weighing up in the tons.

Duraloy metallurgists and foundrymen can do this and do it well. They have done it for years. They know from twenty years' experience how to produce alloys to meet conditions of high temperatures, corrosion and abrasion.

So, no matter the size of your casting or the total tonnage involved, bring your problem to us.

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Great Western Steel Co.

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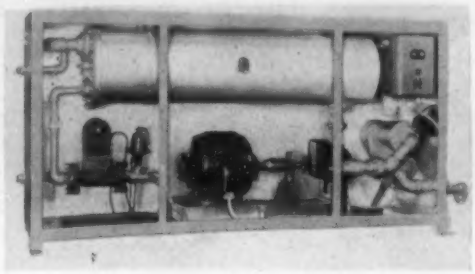
3-DU-1

Quenching Oil Cooler

To meet the current pressing need for accurate control equipment for heat treating processes, the *Bell & Gossett Co.*, Morton Grove, Ill., is producing a complete line of rapid oil coolers. These coolers are used to maintain a constant tempera-



ture in the oil quench bath; a necessity in producing uniform quality in heat-treated metals.

The illustration shows a self-contained oil cooler, which combines the necessary equipment, except the quench tank, in a single unit.

Sequence Timer for Resistance Welding

For use in automatic resistance spot, butt or projection welding, a new weld and sequence timer is announced by *Westinghouse Electric & Mfg. Co.*, E. Pittsburgh, Pa.

Housed in a steel wall mounted enclosure of black crinkled finish, the unit is 17¼ in. high, 12 in. wide and 12 in. deep. On a dead front panel, also of steel, are mounted the individual timing circuit, adjusting potentiometer knobs and dials, repeat and non-repeat switches and the tubes.

The timing circuit is fully electronic and consists essentially of a resistor capacitor whose charging rate is adjustable by varying a resistor. The voltage of the circuit is applied to the grid of a thyratron tube so that after a predetermined charging time has elapsed the thyratron is energized and operates the relay.

The timer divides the total time of a weld into the various intervals in which the welder goes through its operating sequence and includes a "weld" period of 3-30 cycles when the full welding current flows. When welding thick plates, brass or stainless steel, timing facilities permit intermittent heating and cooling steps of from 3 to 30 cycles.

● *Hammond Machinery Builders, Inc.*, Kalamazoo, Michigan, have announced the development of a new cylindrical polishing machine capable of handling ¼-in. to 9-in. outside diam. cylindrical shapes, rods, and tubes, and is reported especially adaptable to the use of abrasive belts with back stand attachments, polishing or buffing wheels. The range of feed of this machine is said to be 0 to 50 ft. per min., forward or reverse.

Heat Treating Aircraft Parts

Tubular parts for the Lockheed Interceptor planes now being turned out for use both by this country and Great Britain are produced in record time at the *Menasco Mfg. Co.* Since these vital parts must be both elastic and tough to withstand the strain of lightning-like Interceptor movements, careful heat-treating is essential.

To accomplish this job, Menasco has installed 4 *General Electric* cylindrical electric furnaces for hardening and drawing, and a water-cooled oil quench. Two G-E atmosphere gas converters maintain an inert atmosphere in the furnaces, and assure that the analysis of gas in the furnaces is constant regardless of changes in the rate of flow.

Heretofore, one of the greatest difficulties in hardening and drawing tubular parts has been excessive cooling encountered in transferring the parts from the furnace to the quench tank. This difficulty has been overcome by installing 2 quenching hoods on the hardening furnaces to protect the parts as they are transferred.

This transfer of parts is accomplished quite simply. After the charge is brought up to the proper temperature in the hardening furnace, a high-speed hoist, equipped with a transfer hood, is brought over the furnace and the charge quickly pulled into the transfer hood. The hood is then positioned over the oil quench tank and the charge quickly dropped into the oil.

This transfer hood minimizes cooling, warpage and scaling of the thin-wall tubular parts during transfer from the furnace to the oil quench tank.

Production

AMERICA'S FIRST LINE OF DEFENSE

Back of our military and naval might and other visible defenses of our nation, is a productive America so great that even Americans fail to grasp its magnitude. It is an America of loyal, patriotic men and women, and machines — almost without number — that multiply the genius of man a thousandfold, and produce a never-ending stream of essential materials to safeguard America and our way of life. Keep production, America's first line of Defense, always moving forward.

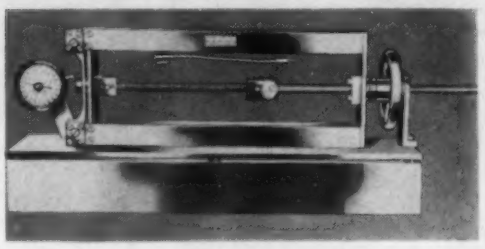
THE ANDREWS STEEL CO.
NEWPORT, KENTUCKY
DIVISIONS
THE NEWPORT ROLLING MILL COMPANY
THE GLOBE IRON ROOFING & CORRUGATING CO.

Basic Open-Hearth Alloy Steel Billets and Slabs

Small Capacity Testing Machine

A small size testing machine for tensile strength or compression testing up to 1,000 lbs. has been announced by *W. C. Dillon & Co., Inc.,* Chicago. The testing machine, as illustrated in the accompanying photograph, can handle standard test lengths of a variety of materials including wire, springs, chain, castings, etc.

Among the features reported for the machine are interchangeable jaws easily removed so that the unit is available for different types of specimens; thrust ball bearings promoting smooth operation; extensometer measurements are easily obtained; and a maximum hand which follows the master hand and remains where



specimen breaks or flexure begins.

Besides this new testing unit, the same company has recently announced the availability of a new type of dynamometer for checking tension in new or established lines such as aviation control cables, wire, rope, etc. With the development of this shunt-traction dynamometer such checking can be done quickly and accurately.

Forced Convection Heating at Elevated Temperatures

The Lindberg Engineering Co., Chicago, has developed 100 per cent forced convection heating equipment for temperatures up to 1,750 deg. F. for such operations as hardening, annealing, normalizing, etc. Previously the convection heating principle was only practical up to 1,300 deg. F.

With this new design, engineers are now able to utilize the advantages of rapid and uniform heating usually attributed to forced circulation heating at higher temperatures.

The heating principle is said to almost completely eliminate distortion of heat treated parts, make possible more accurate heat treating of heavier loads, and save valuable floor space.

Up until the time this equipment was introduced, forced convection heating was assumed to be, by tradition and untried theories, impractical above 1,300 deg. F., but the new developments have canceled these notions, it is stated.

Engine-Driven Arc Welder

A new engine-driven arc welder, which is specially designed for job welding and garage work and which embodies a new system of engine-speed control for maximum fuel economy and minimum engine wear, is announced by *Lincoln Electric Co.,* Cleveland.

With a current range of 40 to 250 amps., the machine can be used for the welding of light gage metal, for the repair of cast iron parts such as engine blocks, for fabrication of machine parts and structures of many kinds, and for hardfacing of worn parts.

Of direct current type, it is said to be able to weld practically all metals and alloys with bare or shielded arc-type electrodes or with the carbon arc where desirable.

● Resurfacing and maintenance of peels, the device used for charging steel scrap into open hearth furnaces, can be an almost endless job at high cost. Working in temperatures around 3,000 deg. F., lifting and rotating pans of scrap steel with total loads up to 5,500 lbs., peels are subjected to extremely heavy abrasion. Wear is speeded by operating temperatures reaching up to 1,400 deg. F.

In recent open hearth service, it was found by the *Harnischfeger Corp.,* Milwaukee, that peels resurfaced with special welding electrodes gave from 4 to 8 times longer service.

DEFECTS
CUT TO LESS THAN 1%

Murex engineers are generally able to help manufacturers solve perplexing welding problems because of their wide and varied experience in many industries with the welding of many products under all kinds of actual working conditions.

Take, for instance, the case of the manufacturer of power boilers. In automatic welding, rejects were high and the chipping and rewelding excessive. The Murex representative made a few seemingly minor alterations in welding procedure, including changing the direction of the slot in the electrode coating to get better slag action.

The result? X-rays from then on showed defective portions to be less than 1%.

It is the obligation of the Metal & Thermit Corporation, through its engineering department, to help manufacturers engaged in war production speed up their welding —whether or not they are Murex users.

Write or phone our nearest office.

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

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MUREX

ARC WELDING ELECTRODES

High-Speed Cutting Tips

A series of oxyacetylene machine cutting tips of a new design, which are said to increase the cutting speed of machine torches by 20 to 30 per cent and at the same time assure cuts of a quality comparable to those obtained with standard tips have been developed by *Air Reduction Sales Co.*, New York.

The new cutting tip has a nozzle with a

divergent exit port. This design makes it possible to eject a narrow, high velocity stream of oxygen, practically free of exit turbulence, and burns a narrower path or kerf through the metal than the conventional cutting tip.

The accompanying illustration shows pieces of scrap cut from a 6-in. alloy-steel block using the newly designed high-speed machine cutting tip.

● *Induction Heating Corp.*, New York, reports a use of thermonic induction heating for brazing which gives a continuous flow of production at the rate of 10,000 units a day. Seven units are brazed at one time, using a silver-brazing alloy which penetrates instantly through the joint. The strength of the braze is as high or higher than the solid parts. As this joint is free from internal oxidation, the need for cleaning or other maintenance is greatly reduced.

Putting Low-Grade Iron Ore to Work

A research project on iron ore, which *Ford Motor Co.*, Dearborn, Mich., pushed steadily along for a dozen years despite meager results, now has opened additional possibilities in metallurgy and for automotive and war production.

Experiments have found a way to recover iron from vast deposits of unwanted, low-grade ore. The iron obtained by this method has some unusual characteristics that make it useful in the new field of powder metallurgy.

Unlike ordinary iron recovered by smelting, the iron the Ford company has obtained is more ductile, it resists corrosion, and it has magnetic properties that improve motor car performance.

Huge deposits of poor ore, much of it in Michigan's upper peninsula, were the original object of the Ford company experiments. Smelting was ruled out as a method of iron recovery because of excessive cost. Research men tried a number of recovery methods and finally settled on electrolysis.

The method of recovering iron from low-grade ore is really a system of electroplating, and for work on an industrial basis, cheap electric power is essential.

The system works this way: Iron is dissolved out of the ore in chemical solution, then is plated out of the solution by electrolysis. One electrode is coated with iron 99 per cent or more pure, which can be removed in sheet form.

Since the sheet contains a slight amount of hydrogen, it is easily pulverized for use in powder metallurgy. On the other hand, if the sheet is heated slightly, the hydrogen is driven off and the iron becomes ductile.

Many uses are being developed for the product of this process. The iron powder can be molded into high-precision gears in a single press operation, producing a gear that needs no machining. Metallurgical engineers explain that molecular cohesion of the iron powder through fusion gives strength to gears or other machine parts made in this way.

Motor car performance may also be improved by using it. For example, cores of distributor coils now in general use sometimes tend to lose their high-spark efficiency at high speeds because the core remains partly magnetized between spark impulses.

The electrolytic iron cores produced in the Ford laboratory have shown high-spark output at all speeds because this type of iron does not retain magnetism between electric impulses.

BARRELS, TABLES, SPECIAL CABINETS

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No matter how tough the test—how difficult the problem—turn to Pangborn for blast cleaning that is QUICKER, CHEAPER and BETTER.

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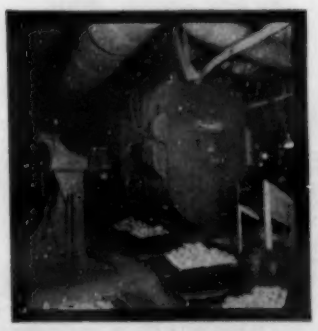

WORLD'S LARGEST MANUFACTURER OF BLAST CLEANING & DUST CONTROL EQUIPMENT

PANGBORN

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Welding Ammunition Boxes

Welding of reinforcements in ammunition box ends has been speeded by the use of the hydromatic welder, shown in the illustration. It incorporates an unusual fixture shuttling mechanism and was developed by *Progressive Welder Co.*, Detroit, Mich.

At the right of the fixture may be noted the assembled part, the job being to weld the channels to the flat plate. With the fixture at the right, the channels and box end are dropped in place and clamped.

The fixture shuttles to the left below the welding point, where 16 welds are performed automatically. While the assembly is being welded, the left end of the fixture has moved to the left of the welding head and an assembled box end is removed and parts for another clamped in place.

The fixture now shuttles back to the right and the second finished assembly is removed. Thus, only two stations are necessary in the fixture, although there are two loading positions and one welding position and no time is lost in loading. Production is at the rate of some 300 assemblies per hr.

The same company has recently developed knee-action, walking-resistance welding guns, which permit the performing of multiple welds in sequence in an automatic machine, where it is preferable to hold the work stationary in large fixtures. Such a machine has been developed for welding the back panel into a refrigerator shell.

The machine is designed to handle two sizes of such shells, and welds one assembly while another is being loaded and unloaded. Shell and back panel are dropped over the locating fixture, which incorporates the lower electrode.

When a button is pressed, the entire operating head of the machine moves to a position above the loaded fixture. Pushing another button starts the automatic welding operation. The 4-gun points come down and make 4 welds.

At the same time, the welding head is moved along by a chain arrangement. The motion of this chain is continuous, carrying the heads of the welding guns along. When the weld is completed, the pressure is off the gun points, and these points swing, under spring pressure, to a new position farther along. Another weld is made automatically, and the guns take another step.

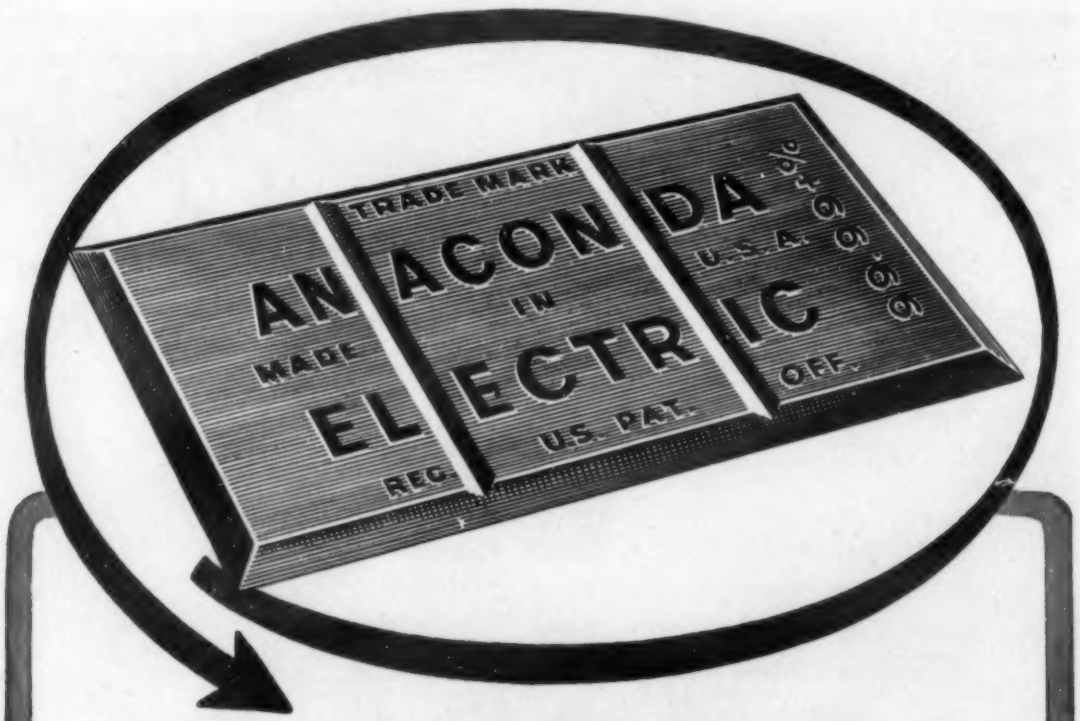
New Tempering and Drawing Furnace

The Johnson Gas Appliance Company, Cedar Rapids, Iowa, has just announced a new addition to their line of industrial furnaces, the No. 820 Tempering and Drawing Furnace.

The manufacturer states that the new furnace speeds the tempering of tools, dies, small parts, non-ferrous castings and parts; and that it can be used for any work requiring a temperature range from 275 to 1,200 deg. F.

Designed as a production furnace, it is compact and requires very little floor space. It is heavily lined with insulating refractory and equipped with two large Johnson atmospheric burners. The counterbalanced, self-aligning door is constructed to reduce heat loss to a minimum, and is easily controlled by a crank at the operator's left.

● *Quigley Panel Constructions, Inc.*, New York, has designed and developed precast panels of an insulating refractory material for furnace structures. The standard panels are 24 in. square and from 3 to 6 in. thick for operating temperature ranges from 1,200 to 2,400 deg. F. The panel constructions are said to present low initial and maintenance costs, combined with operating efficiencies.



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News of Metallurgical Engineers

Raymond H. Rice, formerly chief engineer of North American Aviation, Inc., is now vice president in charge of manufacturing. . . . *D. E. Ralston* has been appointed executive assistant to the general manager, Oldsmobile division of General Motors Corp. He was formerly in charge of the Oldsmobile's automotive operations. . . . *G. E. Burks,* Caterpillar Tractor Co., has been advanced from assistant chief engineer in charge of engine design to chief engineer.

Henry A. Saller has been named a research engineer on the technical staff of Battelle Memorial Institute; *Homer L. Shaw* has been appointed a research engineer on the same staff.

E. Molloy, formerly works manager of Ryan Aeronautical Co., has been elected vice president in charge of manufacturing. . . . *F. P. McKegney* is now chief engineer of the Air Reduction Sales Co. He was formerly assistant chief engineer.

● *S. G. Frantz Co., Inc.,* New York, has developed a permanent magnet ferrofilter which is said to have greater capacity than any previous ferrofilter of this type. It is especially adapted to removal of harmful fine iron and steel particles from circulating coolant systems of machines used in tapping, grinding, deep hole drilling, reaming and rifling, etc.

Heat Treating Shell Cases

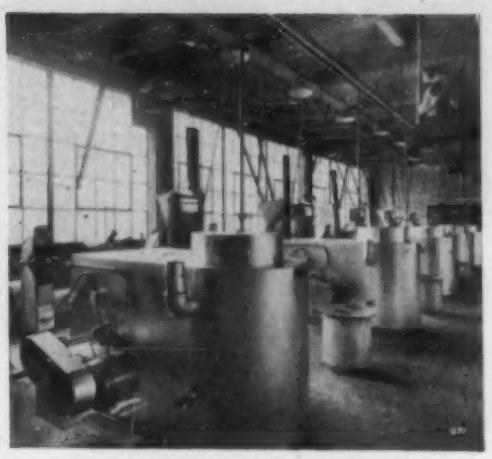
A layout of furnaces for heat treating as high as 4800 20-mm. shell cases per hr. has recently been developed by *Despatch Oven Co.,* Minneapolis, Minn.

The photograph shows a battery of the furnaces used in the system. Notice that all the furnaces are the same size. Even though this provides excess capacity for the blank, cup and first draw anneals, it is considered practical because it makes for more flexibility. It allows for easy interchange of furnaces under all operating conditions, and, consequently, reduces the danger of a bottleneck at any point in the department.

Blanks coated with drawing compound are brought to the drum-type continuous washing machine, approximately 10 ft. long, in boxes. It automatically washes and rinses the blanks and loads them into a furnace basket. The furnace basket goes to the proper furnace by monorail for annealing.

Upon completion of heat treatment, the basket is withdrawn from the furnace and by monorail conveyor goes to the quench. Both air and water quenches have been used successively. After quenching, the basket is moved again by monorail, and the blanks are dumped into a machine that automatically pickles, rinses, and neutralizes them. The clean blanks are returned in tote boxes to the press for cupping. After cupping, the same cycle is repeated and repeated over again for the first, second, third and fourth draws, consecutively.

The pot-type furnace design, employed in the layout, is said to speed up the heat treating, and guarantees proper annealing with uniform grain size from every load. This is made possible by the use of the larger alloy steel fan that transfers heat rapidly from heat chamber to work chamber under terrific pressure to assure heat penetration to every spot in the load.



The result is absolute temperature uniformity through the load in a fraction of the time required in ordinary furnaces.

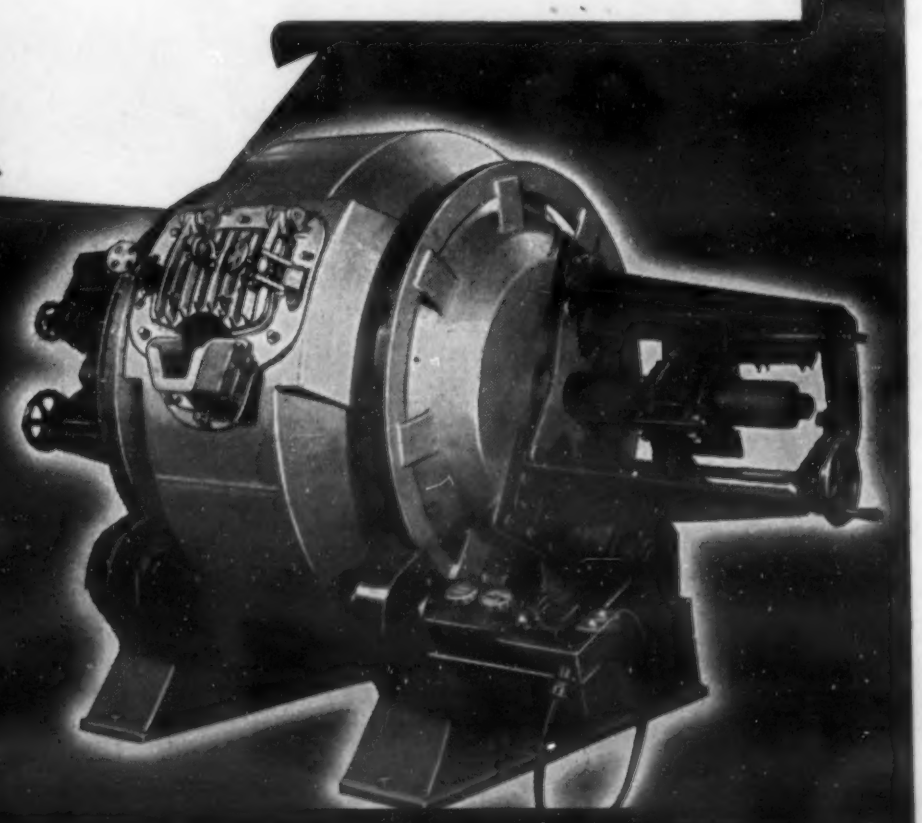
The final stress relief is carried on in a batch-type oven, which is generally placed near the final inspection table or conveyor. In some instances, a continuous conveyor-type stress-relief oven is used, depending on the desired handling methods.

FROM METAL TO ARMS.. *Faster!*

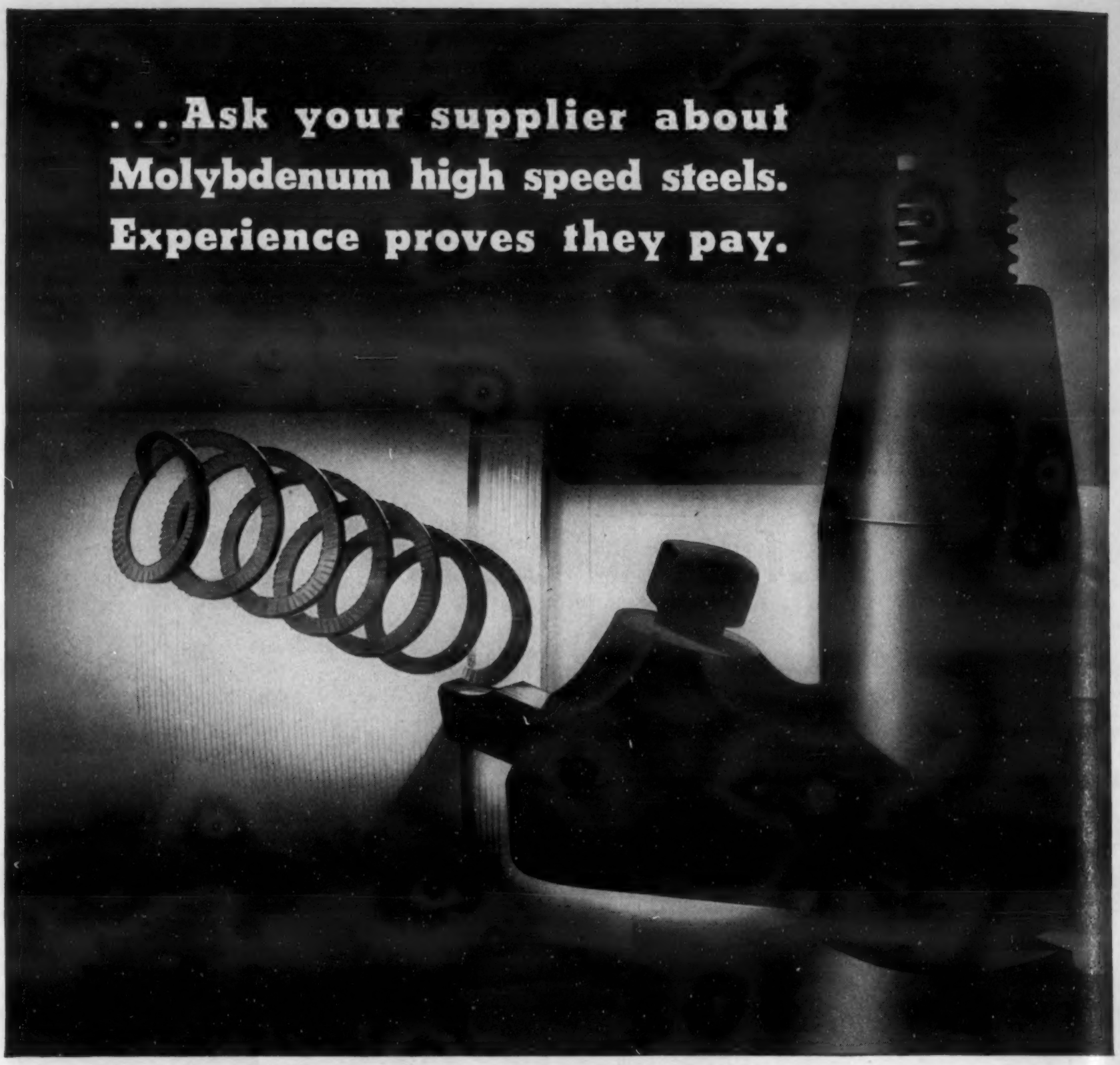
The Detroit Furnace is a fast melting unit. Faster melting speed means a higher rate of production with less labor and greater overall economy. Detroit Rocking Electric Furnaces are being demanded, in ever increasing number, by armament makers.

Working 8, 16 and 24 hours a day, Detroit Furnaces are today melting all types of brass, bronze and other copper alloys; high speed, stainless, heat and corrosion resistant steels; alloy grey irons, short cycle malleable, nickel, monel metal and many other special alloys both ferrous and non-ferrous for America's Arms production.

Not only for productive speed but also for lower metal losses, higher average quality of product, saving in floor space and plant equipment, you simply cannot beat a Detroit Furnace. Write today for further facts.



DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY MICHIGAN



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Equivalent cutting properties Greater toughness Lower cost

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METALLURGICAL ENGINEERING shop notes

Sorting a Mixture of High- and Low- Carbon Steel Parts

by L. Kasper

Recently the problem of sorting a mixed batch of high-carbon and low-carbon steel parts was encountered in our shop, and perhaps the manner in which it was solved might prove of interest to others who occasionally are confronted with the same type of problem.

A large number of small, formed stampings of 1020 steel were being produced. After the final forming, these stampings were to be given an oil quench from a short immersion in a cyanide bath, the object being to produce a shallow, hard case which would withstand slight reforming as required for the assembling operation.

After several hundred thousand of these parts had been blanked, it was discovered that a small quantity of 1095 steel had become mixed with the 1020 steel. As the parts made of the high-carbon steel would be too brittle after the heat treatment, a problem was created, which at first seemed serious, since scrapping the lot would result in too great a loss.

Even a small number of defective parts would result in a bottleneck, with serious results. Both materials were of the same thickness, so gaging could not be used for inspection, but the following simple method was employed and the problem solved with little loss of time.

As the parts made of 1095 steel would harden with a quench from 1450 deg. F., while the parts made of 1020 steel would not be so affected, it was decided to make use of this characteristic in separating the pieces. The entire lot was heated to 1450 deg. F. and quenched in water.

In the first forming operation, which consisted of forming the pieces into the shape of the letter U, the pieces made of 1095 steel, due to their hardness, snapped when struck by the punch and fell through the die, whereas the pieces made of 1020 steel formed to shape were easily separated from the scrap.

Conservation of Welding Electrodes

by Clayton B. Herrick
Lincoln Electric Company

In order that welding may contribute its utmost potentiality in war production, it is important that welding materials be utilized to maximum advantage. This applies particularly to welding electrodes.

There are a considerable number of factors that affect the most efficient use of electrodes. If conscientiously controlled, these factors will result in faster production and a significant saving of material.

The factors which have an important bearing on this situation follow:—

(1) *Select the Right Type of Joint and Be Careful of Fit-Up:* There is a type of joint best suited to each particular job. A serious waste of weld metal results by using a complicated joint where the more simple type of connection will suffice. Since the type of joint greatly affects the amount of metal required, it is suggested that a study be made to make sure the joint is proper for the particular application. Obviously, the joint to select is the one that meets requirements at the greatest speed and the lowest cost.

(2) *Choose the Correct Type of Electrode:* While the general purpose electrode will produce satisfactory welds under virtually every condition, special electrodes as, for example, heavily coated fast flowing types, would prove more efficient. The electrode should be chosen with respect to: (a) physical properties required; (b) type of joint; (c) position of welding; and (d) condition of fit-up of the work.

(3) *Use an Electrode That Has and Maintains a Uniform Coating:* The electrode coating, if not correct, will cause rejects not only of the electrodes themselves but possibly of the welds produced by their use. It should be remembered that the coating controls: (a) fluidity of the metal; (b) penetration; (c) shape of the beads; (d) physical properties of the deposit; and (e) composition of the deposit.

(4) *Use Electrodes That Provide Proper Physical Properties:* Electrodes manufactured today are clearly described by the manufacturer in respect to the quality of weld they will produce. Required physical properties of the work at hand should be known and the electrode should be selected to meet these requirements.

(5) *Use Fast Flowing Electrodes Wherever Possible:* Certain electrodes are manufactured today to permit the fastest possible welding under specified conditions. It is obvious, therefore, that electrode and, hence, time will be saved if these fast-flowing types are used wherever practical.

(6) *Select an Electrode That Keeps Splatter and Slag Loss at a Minimum:* All splatter is a waste of weld metal, and care should be taken to avoid the use of electrodes that have excessive losses.

(7) *Wherever Possible, Use Electrodes That Produce Flat Beads:* It is a waste of welding electrode to deposit any more metal than is required. Not only is the welding electrode itself wasted, but useless time is required to remove the excess metal from the welded joint.

(Continued on page 460)

Characteristics of welds are a good check on electrode conservation. The effect of varying one factor in procedure is indicated below. Note what happens to electrode burn-off rate, weld penetration, appearance of weld and arc sound when the three factors of arc current, arc volts and arc speed are varied from normal.

Arc Current	*Arc Volts*	*Arc Speed*	*Burn-off of Electrode*	*Weld Penetration (Crater)*	*Appearance of Bead*	*Arc Sound*
Normal	Normal	Normal	Normal appearance; coating burns evenly	Fairly deep and well defined	Excellent fusion; no overlap	Sputtering hiss plus sharp crackling
Low	Normal	Normal	Practically same as preceding	Not very deep or well-defined	On top of plate. Not as much overlap as with bare rod	Irregular sputtering, some crackling
High	Normal	Normal	Coating is consumed at irregular high rate; watch carefully	Deep, long crater	Broad, thin bead; good fusion	Regular explosive sounds
Normal	Low	Normal	Coating too close to crater, touches molten metal, resulting in porosity	Small	High bead not as pronounced as for low amps.; somewhat broader	Hiss plus steady sputter
Normal	High	Normal	Drops at end of electrode flutter and then drops into crater	Wide and rather deep	Wide spattered	Soft sound plus hiss and a few crackles
Normal	Normal	Low	Normal	Crater normal	Wide bead; overlap large. Base metal and bead excessively heated	Normal
Normal	Normal	High	Normal	Small, rather well-defined crater	Small bead; undercut; reduction in bead; size and undercutting depends on speed and amps.	Normal

(8) *Select the Right Size Electrode:* The largest diameter electrode that can be used effectively is the best from the standpoint of electrode conservation.

(9) *Use Long Electrodes in the Larger Size:* The obvious result is the reduction in the number of stub ends and in the time saved by eliminating interruptions to change rods. The 18-in. length should be used in ¼-in. and larger sizes.

(10) *Do Not Bend Electrodes:* This generally unnecessary habit will waste from ¼ to ⅓ of the electrode.

(11) *Use Proper Voltage and Current Settings:* Every electrode manufactured is designed to operate at a certain voltage and within a specified current range. If current is too high or too low, it will manifest itself either in excessive splatter loss or inferior welds.

(12) *Follow the Procedure Specified for the Electrode:* Accompanying each different electrode manufactured are detailed specifications regarding procedures to be followed, and if followed consistently, will prevent waste of electrode and assure high quality welding.

(13) *Avoid Using an Excessive Number of Beads:* If one bead of weld metal will meet design requirements, it is obviously a waste of electrode to add additional beads.

(14) *Use Electrode Down to Minimum Stub End:* Remember that the electrode can be used the entire length of its coated surface. Leaving any more than a minimum stub end is an obvious waste. By using care in gripping the electrode at its extreme end and burning it down to the maximum extent, the operator is rendering a patriotic service in saving electrode.

(15) *Collect and Save Stub Ends of Electrode:* At the rate in which welding is being used today in war production, the amount of metal which would be wasted by failure to save stub ends would be tremendous. The average stub end is 2 in. long and this length, multiplied by the millions of electrodes used, would constitute a great loss.

Removing Stains on Cartridge Cases

by J. J. Healy, Jr.

Monsanto Chemical Co., Merrimac Division

A troublesome problem in the manufacture of brass cartridge cases has been solved through the use of a common and well-known chemical, ferric sulphate.

Ugly red cuprous oxide stains and black smut are frequently left on the surface of the brass after heat treating operations used in cartridge case manufacture, and they have been difficult and sometimes impossible to remove by the usual acid pickling methods. By making a pickle solution containing ferric sulphate in addition to the usual acid, however, complete removal of stain can be achieved.

Sulphuric acid alone will remove the more common black cupric oxide, but it is not effective against smut or red stain, with the result that these blights are a frequent cause of trouble in the pickle room.

To assure complete elimination of stain, ferric sulphate should be used in each pickling operation, starting with the first anneal. If any red cuprous oxide or black smut remains after pickling, and is subsequently drawn into the piece, it becomes difficult to remove.

The use of ferric sulphate in pickling cartridge cases not only improves final finish but produces a finish more satisfactory for intermediate draws.

Metallurgical Engineering Digest

FERROUS AND NON-FERROUS

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Foundry Patterns for Quantity Work

"Pattern Equipment for Quantity Production of Small and Medium Castings." F. G. Butters. *Foundry Trade J.*, Vol. 65, Dec. 18, 1941, pp. 391-394, 396. Practical review.

Wood patterns can be built up in pine or mahogany, especially the latter, to meet all normal requirements of hand or machine molding. Warping is a characteristic disadvantage common to wood.

The metals used in pattern construction cover a fairly wide range, including cast iron, brass, white metal, aluminum, magnesium, etc., each possessing characteristic qualities that usually determine their selection for pattern equipment. Of the above-mentioned metals, cast iron is the one most generally used, and with few exceptions possesses all the more important qualities necessary.

The use of brass is largely confined to the actual pattern or section of pattern, with the pattern itself being mounted on plates of either wood, cast iron, aluminum or steel. White metal is invaluable for the lining of intricate stripping plates, this latter application being the means of effecting an appreciable saving in time and labor in pattern mounting. The substitution of lead as an alternative is not generally recommended, owing to its exceptionally soft nature. Because of its exceptional lightness, aluminum has a wide field of application.

Like cast iron, it can be used exclusively for almost any type of pattern equipment, including flat plates to be machined for mounting purposes; single-sided plates for hand or machine; double-sided plates for hand or machine molding; or loose patterns for hand molding. Although the major advantages of this metal are its low ratio of weight to volume, it also shares the advantages of other non-ferrous metals regarding immunity from the effects of rust and chill, and is reasonably resistant to the abrasive action of sand.

Precautions in the working of aluminum are necessary to combat the danger of pronounced liquid shrinkage in heavy sections; this in some cases involves a drastic change in the technique of running and feeding, and in some instances necessitates the application of chills or denseners. The pouring temperature should also be carefully controlled, 1300° F. being reasonable for small patterns. AIK (1)

1a. Ferrous

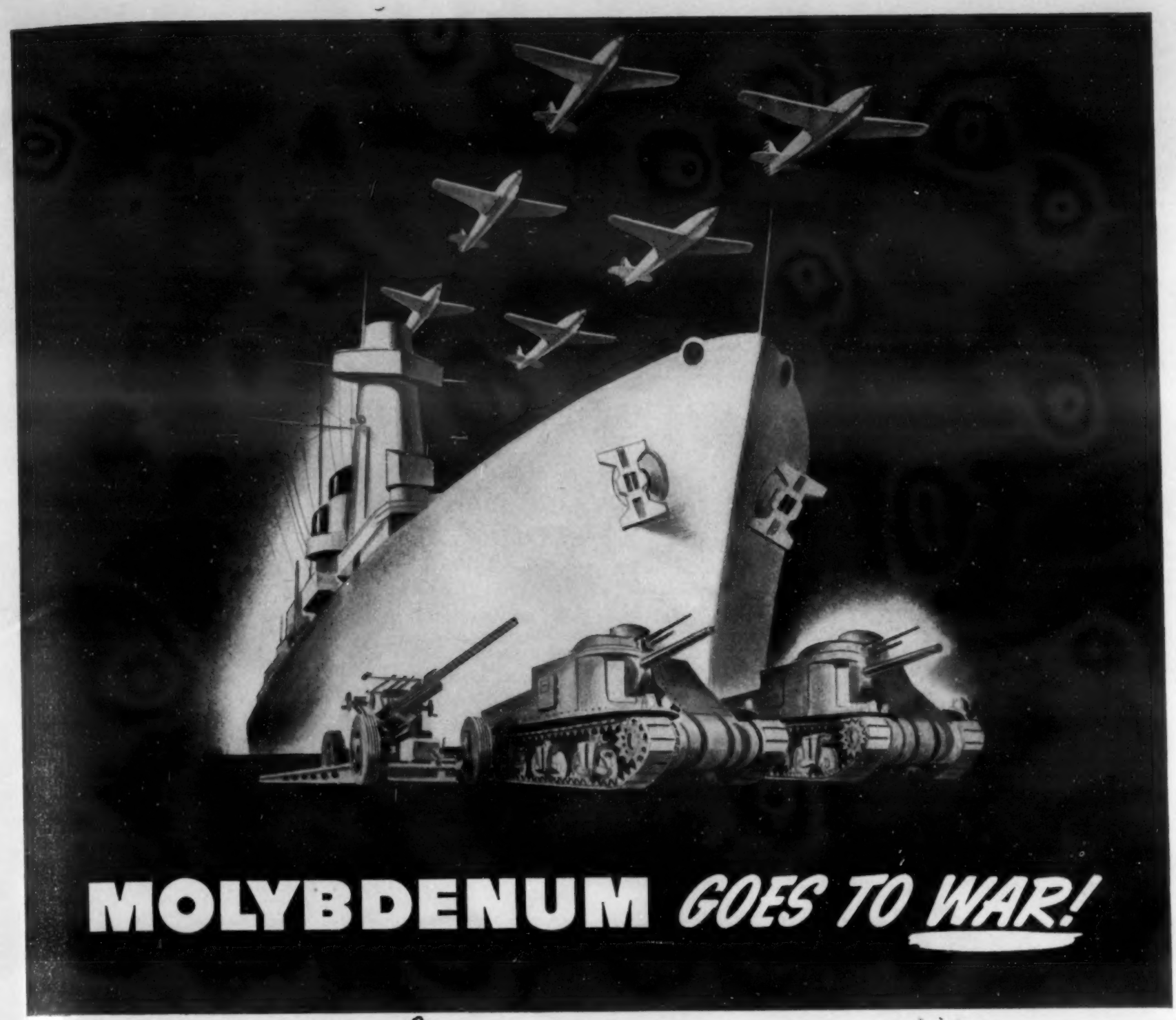
Electrolytic Production of Iron Sheets

"Influence of Operating Conditions on the Electro Deposition of Iron Sheets." (In German) F. Muller & O. Witnes. *Z. Elektrochem.*, Vol. 47, Feb. 1941, pp. 135-143. Original research.

The effect of surface condition of the cathode on adherence of the deposit, and the causes of hardness and brittleness are investigated. The experimental set up is described in detail.

In order to obtain easily-detachable nonporous sheets it is necessary to maintain a uniform oxide film on the cathode. This can be accomplished by pre-treatment of the cathode and by adjusting the acid concentration of the electrolyte.

With a cathode that was rinsed with water after de-greasing and with high acid concentration the deposits adhere firmly at different points. With slightly reduced acid concentration the deposit is easily taken off, especially when the cathodes are introduced into the bath while the current is



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on. Cathodes of aluminum, chromium-plated iron and oxidized iron plates yielded deposits that were easily taken off.

However, when the cathodes were treated with hydrochloric acid introduced while wet, the deposits adhered firmly. Addition of 1.5 to 2.0 g./l. of aluminum chloride to the iron chloride solution had an unexpectedly favorable influence on the ductility of the deposit.

Spectographic analysis showed that no aluminum had entered the deposited metal. Similar results were obtained with beryllium chloride and especially chromium chloride. The soft electrolytic plates could be further softened by annealing at 660° F. and 840° F., while the brittle deposits required higher annealing temperatures. RPS (1a)

Rolling Stainless Sheet from Ingot

"The Experimental Rolling of Sheet from Large Stainless Steel Ingots." D. Gurevich & S. Belorusov. *Iron & Steel,* Vol. 14, Sept. 1941, pp. 431-432, 437. Experimental.

The production of thin sheet from stainless steel ingots weighing 9.5-10 tons is possible.

Ingots cooled to a temperature of 480°-660° F. can be heated in the pits to the rolling temperature in 9-10 hrs. Heating of the ingots to 2150°-2175° F. permits rolling to slabs; the temperature at the end of rolling should not be below 1650° F.

Yields may be as much as 70%. Rolls should be carefully checked for cleanliness, dimension, etc. before rolling. Chemical heterogeneity is practically absent in 9.5-10 ton ingots. CBJ (1a)

Coke Properties and Blast-Furnace Operation

"Correlation of Some Coke Properties with Blast-Furnace Operation." Hjalmar W. Johnson (Inland Steel Co.) *Metals Tech.,* Vol. 8, Dec. 1941, 34 pp. Operating data.

Although blast-furnace operation is dependent on the quality of the coke used, operating data cited in this paper prove that a change in the characteristics of the coke used in several blast furnaces may result in improved operation of one furnace and poorer operation of other furnaces. This is due primarily to the manner in which the burden settles in a furnace and to the difference in travel upwards of the gases in different furnaces.

The manufacture of coke is divided into 4 steps: (1) selection of coals, (2) preparation of the coal charge, (3) heating, (4) pushing and preparation. In the work described detailed investigations were made of the manufacture when there were changes in the size. Of the many variables investigated, coking time and temperature were found to be most significant.

Before considering the quality of coke used, it is first necessary to adapt the furnace to the coke available. No conclusion regarding the quality of coke is worth while until the best possible gas flow has been worked out for the particular furnace. For most plants, the source of coal and equipment available are fixed. The problem is to make the product most useful for most efficient blast-furnace operation.

More is to be gained if less attention is paid to objective measures and more to the control of the many variables that in combination produce blast-furnace coke. Any improvement in control will result in a more constant product, and this in turn will facilitate study of the results in the blast furnaces. Then by controlled experiments the optimum coke for a particular plant can be readily determined. JLG (1a)

Desulphurization of Pig Iron

"Desulphurization of Pig Iron." *Foundry Trade J.,* Vol. 65, Dec. 11, 1941, pp. 379-380. Review.

The exploitation of new iron ore resources has directed increased attention to the economic desulphurization of pig iron, especially in Germany. Reviewing developments in this direction in Report No. 191 of the blast furnace committee of the Verein deutschen Eisenhüttenleute, published in *Stahl und Eisen,* W. Eihholz & G. Behrendt refer to the extensive research carried out on the comparative efficiency of various desulphurizing processes.

The wide difference in sulphur content throughout a tap suggests that desulphurization might be effected in the blast furnace itself, by maintaining a sufficient amount of a reactive slag over the molten charge. The marked drop in sulphur content is due to the fact that if enough slag is present in the furnace, the droplets of iron become desulphurized in their passage through the slag, so that the thicker the slag cover the greater the degree of desulphurization.

For instance, W. Oelsen points out that sodium silicate can remove appreciable quantities of iron sulphides from molten charges. Trials have shown that the principle of the process is sound provided the slag can be maintained at a sufficiently high temperature.

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Observations were conducted by the first-named authors on over 200 tappings with each of 2 blast furnaces, one operating with soda ash and the other with a mixture of soda ash and lime. The authors found the marked superiority in certain cases of a 4/3 soda ash/lime mixture over a 5/3 mixture and plain soda ash, this result applying only to reaction in the blast furnace.

Oelsen had previously called attention to the formation of a double carbonate on fusing together soda ash and $CaCO_3$ (limestone). This carbonate melts at 1500° F., or some 90° F. lower than soda ash. The molten double salt, when added to the iron, caused violent reaction.

Contrary to expectation, desulphurization was found to be less efficient than with plain soda ash; the same result was obtained with the sintered carbonate. The reason for this lack of improvement is that the highly fluid salt after reaction forms a very viscous slag, which may solidify and then become totally ineffective.

Experiments were also conducted to find a difference between the action of solid and molten soda ash. The solid soda ash was found to be more effective than the molten reagent.

Various advantages accrue if desulphurization is effected after the metal is placed in the mixer: the pig iron poured from the mixer contains no furnace slag, temperatures and other factors are more uniform, etc. The disadvantages are lower reactivity of agent because of lower pig iron temperature and a probable reduction in converter life.

Good results can only be achieved if the throughput of the mixer is maintained fast enough to keep the pig iron hot. The soda ash required for desulphurization behind the mixer is roughly half that needed for a similar result in the furnace; also, it is not always possible to reduce below a certain final sulphur value by continually increasing the amount of soda ash added.

A point to be noted is that the soda slag must not pass into the converter when the charge is poured from the ladle; the authors recommend the use of a slag catcher of the type adopted at Corby, which also permits part of the slag to be used again, thus reducing soda ash consumption.

Experiments indicate that desulphurization with lime in a rotary furnace is a practicable proposition, giving desulphurization rates of 0.35% S/hr. with a 6-10% lime consumption, and the addition of 2-3% C for reduction. Desulphurization can be taken to extremely low values in the rotary furnace, but this requires a long time. An unexplained feature of this process is the very large amount of iron (10%) that is lost. It is believed that these losses can be reduced by cutting down the quantity of lime added. AIK (1a)

Iron Castings for Machine Tools

"Turret Lathe Castings Must Be Perfect." Pat Dwyer. *Foundry*, Vol. 70, Jan. 1942, pp. 58-61, 148-150. Descriptive.

The procedure at the Sterling Foundry Co. in making turret lathe castings for Warner & Swasey is interesting in several respects.

With the exception of the larger sizes, all molds are green sand made in iron flasks. Large molds are black-washed, covered with steel sheets and skin-dried.

Lathe bed or body patterns are split through the center longitudinally so that the mold and cope may be molded side by side. Each half is attached in proper position on the board so that cope and drag will coincide.

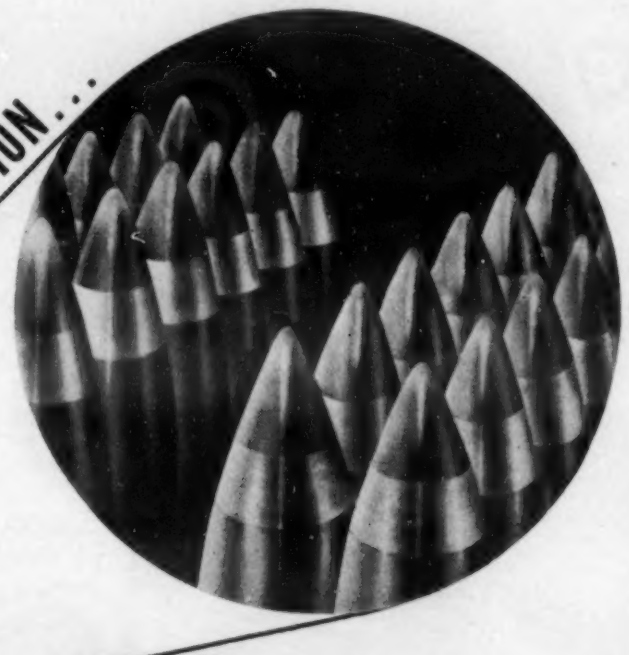
The flask pin holes are drilled through a jig. The location of the pattern is accurate and the joint line of mold is more uniform than where the cope half of the mold is rammed on top of the drag. The number of fins along the joint is reduced to a minimum.

The charge used contains from 70 to 90% steel, with resulting low carbon and high silicon in the iron. By controlling the carbon to 2.70 to 2.85%, a hardness range of 241 to 269 Brinell is obtained.

With this product, a combination of good machinability and high hardness was achieved, and the machined finish was excellent, but occasionally wearing surfaces were scored or galled. A series of investigations showed that the presence of primary ferrite caused galling. Temperatures above a certain range produce primary ferrite or free cementite.

The primary ferrite areas were found in castings in which the carbon content was somewhat below normal. Irons heated to 2850° F. or over showed a greater tendency to produce primary graphite than irons heated to lower temperature.

In the early experiments, graphite was added in the ladle to induce flake formation, with definite improvement in metal. In latest experiments, ferrosilicon has been added at the spout. The silicon is reduced 25 to 50 points in the base mixture and then replaced by the spout addition. A small amount of primary ferrite is still



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formed but it is confined to small areas where it can be removed by machining.

Different types of test blocks are used. A quick-test chill-block is formed in a green sand mold, where the bottom and one side of the mold are iron chills.

Another block is used to study the interior of heavy sections. The block first is broken across the center for visual examination; then, two narrow channels are cut and the piece is subjected to chemical analysis.

The metal is melted in 2 cupolas, one lined to 48 in. and the other to 54 in. inside diameter. VSP (1a)

Drying Open Hearth Stopper Rods

"Inexpensive Stopper Rod Drying Oven." H. T. Klein (Continental Steel Corp.) *Steel*, Vol. 109, Dec. 1, 1941, pp. 93-94. Descriptive.

Thorough drying of stopper rods for open-hearth ladles is an important factor in efficient pouring practice. A drying-oven built at the Kokomo, Ind., plant of the author's company thoroughly dries the rods efficiently and economically.

The slag remaining in the ladle after pouring the steel is the only source of heat for drying. Immediately after pouring the last ingot, the slag is poured over top of the ladle into a small slag thimble. As soon as the slag has solidified sufficiently to be handled safely, the thimble is placed in the oven.

One thimble of slag per day is sufficient for drying the rods. The oven is located in the open-hearth pit. Handling of the rods is done by the ladle crane auxiliary hoist. A portion of the oven, 14 ft. 11½ in. by 5 ft. 7½ in. and 6½ ft. deep, is a pit below the ground, and is lined with used checker brick. The superstructure, fabricated from steel plate, is 9 ft. 7 in. high and covers all but a 6 ft. 4 in. by 5 ft. 7½ in. opening to the pit. The slag thimble is lowered into the pit through this opening, which is covered by a steel plate after the thimble is in place.

The superstructure has a firebrick lining supported by angle irons at the bottom of the plate, and is divided into 2 sections, one with a capacity of 36 rods and the other 24. The rods are suspended in the oven on notched plates, which are designed to support each rod by the nut used in securing the rod to the ladle stopper rigging. These plates are placed on top of the brick lining and are 15 in. below the top of the oven. Clearance between stopper head and floor pit is about 2½ ft.

Steel doors at the top of the oven are hinged at the sides and are kept closed except when the rods are being transferred in or out. A definite drying cycle is always maintained by removing the rods from the oven in sequence.

Two stopper ladles are used exclusively in the shop, and 2 spaces are left open in the oven so that the green rods may be placed before the dry rods are removed to the ladle. To allow for expansion, the nut holding the stopper sleeves in place is loosened before the rod is placed in the oven.

As the rods are in a vertical position from the time they are placed in the oven until the heat is poured, there is little chance of cracking the joints or warping the rods. A screw-type stopper head is used and no trouble has resulted from having the weight of the sleeves directly on the head. This oven capacity is ample for a 5-furnace shop. MS (1a)

1b. Non-Ferrous

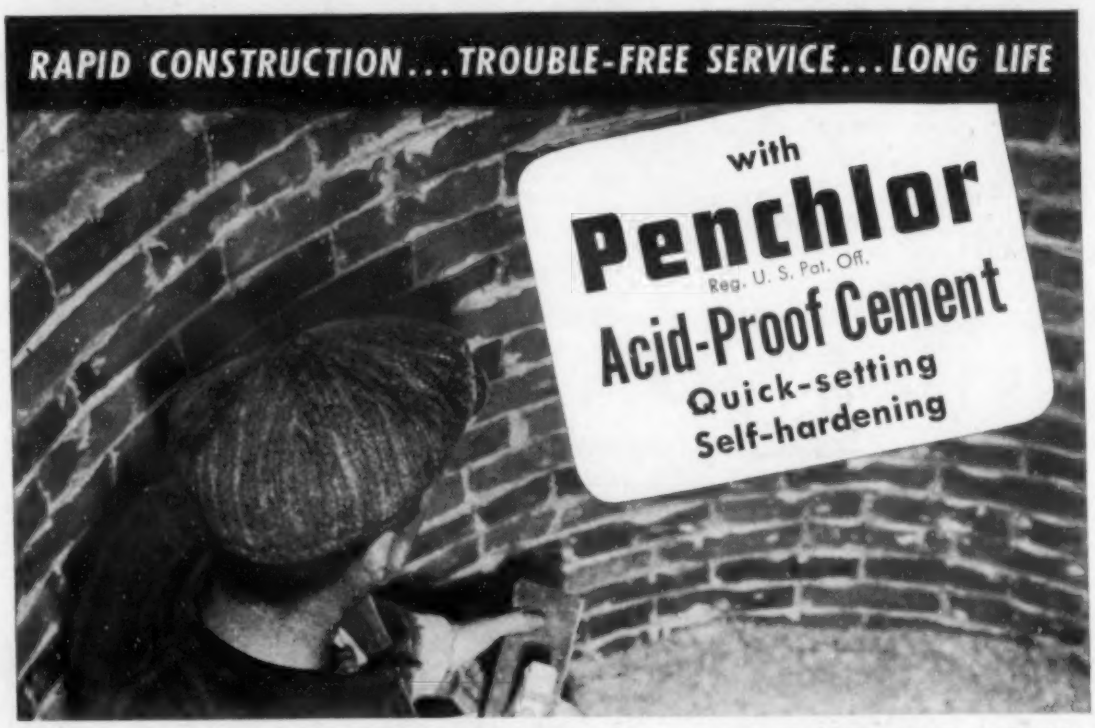
Reclaiming Aluminum Scrap

"Aluminum Scrap Conservation." A. J. T. Eyles. *Sheet Metal Inds.*, Vol. 15, Dec. 1941, p. 1551. Practical.

Although few are recovering more than 75% of aluminum in ordinary dirt-laden turnings, recovery can be as high as 90-95% of cleaned turnings, 80-95% of scrap castings, 80-97% of painted sheet, and 83-95% of used sheet. Feeding dirty and painted aluminum scrap into the molten electrolytic baths used for producing pure aluminum will contaminate the electrolyte.

The main difficulty in remelting scrap is that aluminum oxidizes easily but the oxide does not readily separate from the molten metal since the specific gravity of the oxide is almost the same as that of the metal. If the scrap is kept just above the fusion point and the globules of molten metal are made to coalesce by hand puddling, the oxide skin is broken so the globules can unite.

Clean globules can also be obtained by using a flux that dissolves the oxide skin. Volatile fluxes such as zinc chloride and sal ammoniac are useful near the end of the puddling process, but give very low recoveries in melting aluminum scrap sheet, etc., without constant stirring. A flux mixture of 85% sodium chloride + 15% chloride is most useful if used in large amounts (20-25% of the weight of scrap) and if mixed with scrap before charging.



PENCHLOR ACID-PROOF CEMENT is used to make the mortar with which these acid-proof bricks are being laid in lining a tank to store hot dilute sulphuric acid at the chemical by-products plant of the Chesapeake-Camp Corp., Franklin, Va. Construction Contractors: A. Lynn Thomas Co., Inc., Richmond, Va.

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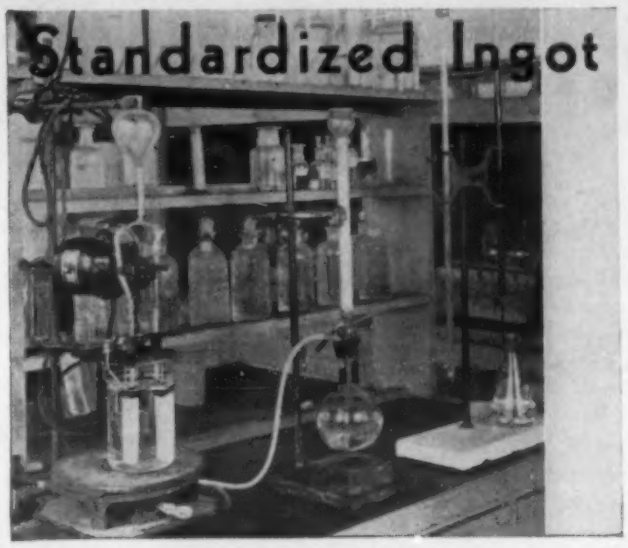

A copper-silicon-zinc alloy of the useful and versatile "Tombasil" family has been developed expressly for the war trend in nonferrous castings.

Its use releases relatively large quantities of tin used in bronze alloys formerly required for such castings.

According to exhaustive laboratory and field reports, this new alloy, known as Ajax **Navy Tombasil**, possesses physical properties far in excess of either Govt. "G" Bronze (88-10-2 and 88-8-4), Spec. 46M6G; or "M" Metal, Spec. 46B8G; as well as the Cu. Si. Alloy known as Spec. 46B28.

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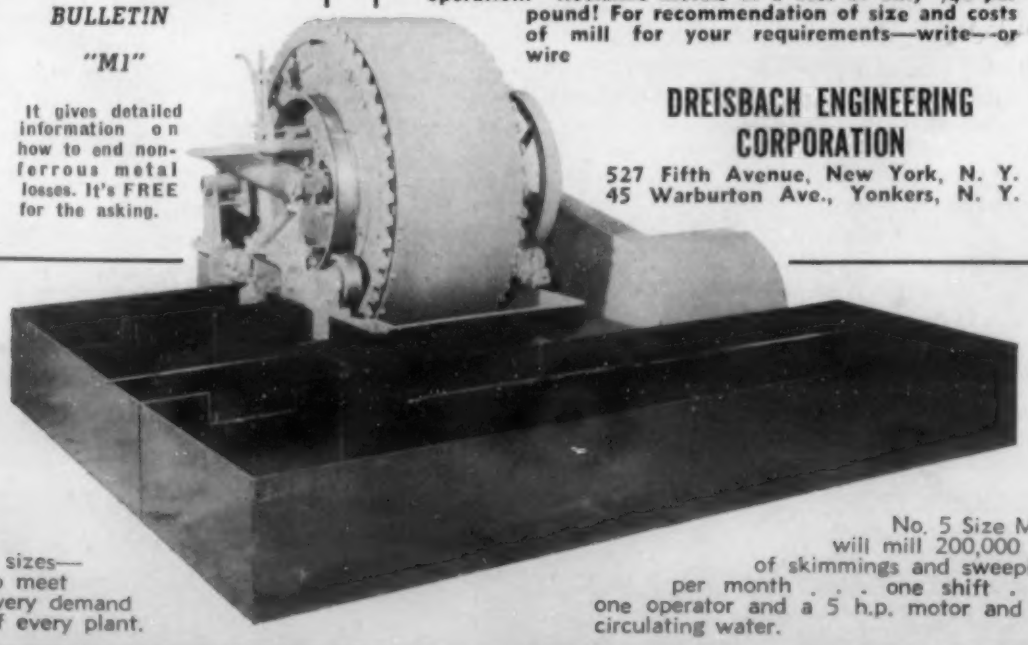

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Since the second method requires much higher temperatures than the puddling method, plumbago crucibles or a reverberatory furnace are required. Iron pot furnaces are most suitable for the puddling process (iron pots should be well coated with thin clay wash or graphite mixture—1 part graphite to 2 parts water). The flux method does not give higher results than puddling process with clean cuttings, but labor costs are less since constant puddling is not required.

The presence of dirt, oxide, oil and moisture cause low recoveries and should be eliminated as far as possible. Briquetting methods decrease melting loss, melting time, and fuel cost, but involve expensive machinery. Baled scrap gives about 3% higher recovery than loose scrap. Overheating should be avoided in any case.

JZB (1b)

Melting Magnesium Castings

"Melting Technique in the Magnesium Foundry." *Light Metals*, Vol. 4, Nov. 1941, pp. 216-127. Practical.

One of the chief differences in melting magnesium alloys compared to aluminum alloys is the absence of gas absorption in melting the former metal. Excessive oxidation must be of course avoided, but the furnace conditions are not as critical as in melting aluminum.

Oil-fired or gas-fired furnaces are most commonly used for magnesium alloys. Coke furnaces are not recommended because of the danger of contamination of the sand by carbonaceous material. Carbon monoxide may be formed and cause blow holes during pouring.

Cast iron or pressed steel crucibles are used in melting magnesium, since magnesium is inert with respect to iron. Plumbago or carborundum crucibles can not be used with magnesium because of a reaction that forms magnesium silicide; also, the fluxes used for magnesium melting attack ceramic materials.

Fabricated steel pots have a longer life than cast iron pots. The steel pots are lighter, and hence make for greater ease in handling.

Each pot should be carefully inspected daily to locate any weak spots or cracks. The pot is filled with water to soak off the encrusted oxides and nitrides. The pots are then thoroughly dried and brought to a red heat. If there are portions of a duller red than the general hue, it will often be found that such areas correspond to flaws, and if so, the pot should be scrapped.

When the pot has passed the "red hot test," it should be cooled to room temperature and struck with a hammer. If the ring sounds suspicious, hammer blows should be directed at all portions of the crucible to see if there is any local denting. If denting is possible, the pot should be scrapped. Pots should be examined with particular care at the flux level and at the bottom.

The pot, if it passes inspection, is filled with the charge, and a small amount of flux (having a base of anhydrous magnesium chloride) is added. More flux is added from time to time, so that a continuous flux cover is present when the charge is entirely molten. At 1380° F. the heat is cut off, and the flux cover removed.

The metal is now ready for refining. Flux in amount of 2% of the weight of the charge is added, and thoroughly stirred into the melt. The flux residue is then either removed, or allowed to settle, depending on its characteristics. A similar quantity of flux is added to form a continuous cover, and the temperature raised to 1560°-1740° F. for refining the grain.

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33-47

After 10 min. at this temperature, the heat is quickly cooled to the casting temperature. The effect of superheating on grain refinement is more noticeable in sand castings than in chill castings; in the latter the grain size tends to be small regardless of superheating. The fluxes used for refining and covering are often somewhat different in composition.

In magnesium alloy melting, every melting is also a refining operation, so that magnesium never becomes "secondary metal" in the sense that aluminum does. However, clean scrap must be used. Foundry scrap must be cleaned from all traces of sand with a wire brush, or by shot blasting.

The average furnace will melt 2 lbs. of magnesium per min., but this does not include the superheating operation. If this extra time is taken into account, the average overall melting time will be about 1 lb. per min.

Thus far the melting process is the same whether sand casting, permanent-mold casting or die casting is to be used. The value of superheating in the case of die casting or casting in which the metal is ladled out of the pot a little at a time, is questionable, and should be decided by actual fracture tests on the parts being cast.

The metal loss in a sand foundry is usually about 5%, while in die casting, where much longer holding times are employed, a loss of 8% should be expected. Instead of the usual holding pot with a flux cover, a comparatively new method that has certain advantages utilizes an atmosphere of sulphur dioxide over the hooded pot, with sufficient draft so that the sulphur dioxide introduced at several points just over the liquid level passes up the flue. In this manner, an invisible protective curtain is formed, which allows ready access to the pot with a ladle. AUS (1b)

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Rolling and Annealing of Copper Strip

"Influence of Crystal Structure on the Cold Rolling and Annealing of Copper Strip". Maurice Cook & T. L. Richards. *J. Inst. Metals*, Vol. 67, 1941; abstracted in *Metal Treatment*, Vol. 7, Winter 1941-1942, p. 170. Investigation.

X-ray and microscopic methods are used to determine the effect of progressively increasing cold-rolling reductions and of subsequent annealing on high-conductivity copper strips having 4 different types of crystal structure. The same twin-fibre textures are ultimately developed with increasing rolling reductions in strips possessing all 4 types of initial structure.

The degree of preferred orientation of crystals in the strip developed on rolling, although dependent on the degree of preferred orientation before rolling and on the magnitude of the rolling reduction, is independent of the initial grain size. Some strips with certain types of structure, and particularly strips having a small grain size before rolling, showed, after very heavy rolling reductions, self-annealing effects.

The effect of rolling reductions up to about 50% and subsequent annealing is to develop a random orientation of crystals, but a rolling reduction of about 25% is necessary to eliminate from the strip any preferred orientation present before rolling. The twin-fibre textures developed in strip rolled with reductions in excess of about 50% can either recrystallize independently to form a double-texture structure or can coalesce to form a single-texture structure, depending, in general, on the initial grain size and the magnitude of the final rolling reduction.

Increasing the final annealing temperature has, with a few exceptions, little effect on the final structure other than to increase the grain size of the strip. In certain circumstances, high final rolling reductions and high final annealing temperatures give rise to the development of abnormally large crystals.

Pronounced directionality, as shown by tensile tests and earing on cups, is developed under certain conditions, and the 2 types of directionality noted, as well as the crystal growth characteristics, have been related to the crystal structure. (1b)

The
INDEX
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One of our metallurgists will gladly call at your request to tell you more about S. M. Ferrochrome and give you practical help in its use. He can tell you also about many other "Electromet" ferro-alloys that help to improve the quality of steel and increase the speed with which it can be made. This service — backed by more than 35 years' experience in the production and use of quality ferro-alloys — is yours for the asking.

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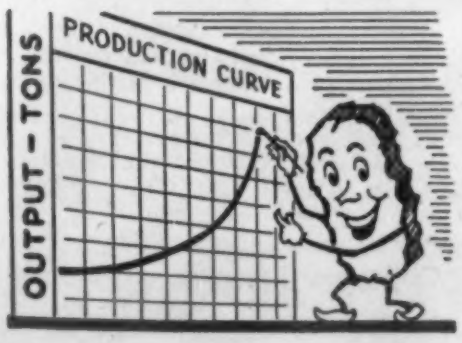

Silico-Manganese Is a Quick, Thorough Deoxidizer — Silicomanganese combines the effects of two powerful deoxidizers. This combination dissolves rapidly in the molten metal and forms a light, fluid, low-melting manganese silicate slag which quickly rises to the surface and leaves the steel clean and ready for tapping in 10 to 15 minutes.

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permits these steels to be used in the as-rolled and as-welded state without subsequent annealing.

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Calcium-Manganese-Silicon Improves Ductility of Steel Castings — Used as a deoxidizer in the ladle, calcium-manganese-silicon decreases the amount of aluminum sometimes considered necessary to make solid castings poured at high temperatures in green sand molds. Such castings have improved ductility.

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If you want more information about these and the many other "Electromet" ferro-alloys and metals and the service that goes with their purchase, write for the booklet, "Electromet Products and Service."

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Spot Welding

A Composite

Spot welding, fast attaining its "majority" through its growing use in the growing aircraft industry, is still a mystery to many engineers in that and other fields who should know more about it in order (a) to understand when it should be specified as a fabricating process or (b) to make proper use of it once it has been specified.

Spot welding as an aircraft fabricating process was discussed in these columns in our February issue (p. 302) and in the December issue, its application specifically to aluminum alloys was examined. Some factors of broad interest in the use of spot welding for fabricating several metals in a variety of industries were reviewed in 4 papers given at the recent American Welding Society meeting and published in the Oct. 1941 *Welding Journal*.

Spot Welding Control

Spot welding control is not an adventitious thing or something heaven-sent to help harassed engineers, but must be carefully planned and supervised to achieve the best results. The functioning of a control laboratory is described by J. R. FETCHER, of E. G. Budd Mfg. Co. ("Spot Welding Control and Supervision," *Welding J.*, Vol. 20, Oct. 1941, pp. 673-677). The job of the laboratory is to specify and describe the weld that the fabrication shop will produce with a guaranteed strength.

Ranges of electrode pressure and current settings for a definite time cycle are mapped out for attaining definite strength values per spot. The shop then sets the schedule between the limits so as to achieve 15% greater strength than designed for. Automatic supervision of weld quality is obtained by means of a "weld recorder," which detects variations in time and current, and makes the welder inoperative when a 15% drop in either I^2 or T occurs.

The "set up" supervisor makes and records pull and etch tests on the welds, and the inspection department checks appearance, location and number of welds. This procedure has been successfully applied to stressed stainless steel aircraft structures, and has made it possible to place the correct number of spots in a joint the sum of whose strengths totals the design-strength of the joint.

Shear strength *vs.* current curves for different gages of various ferrous materials are presented by A. M. UNGER, of Pullman-Standard Car Co. ("Structural Spot Welding—Consistency Control Methods", *Ibid.*, pp. 687-693). The seriousness of a slight decrease in current is indicated and the opinion is expressed that any device which merely indicates current variations is inadequate in that a poor weld has already been made before it is known.

A compensator is described (based on an expired patent) that compensates for a drop in current by an increase in time of welding. A successful compensator has now been developed which maintains the current to a spot weld constant regardless of the line voltage variations. This compensation is brought about by automatically shifting the phase control of the welding current.

Curves are shown of per cent reduction in open circuit line voltage *vs.* per cent of weld strength at normal voltage; for a 15% drop in voltage the compensator permits approximately 95-98% of strength to be attained, while without the compensator the strength is cut in half. The tests indicate that satisfactory strengths can be obtained with the compensator even with line voltage reductions amounting to 30% or more.

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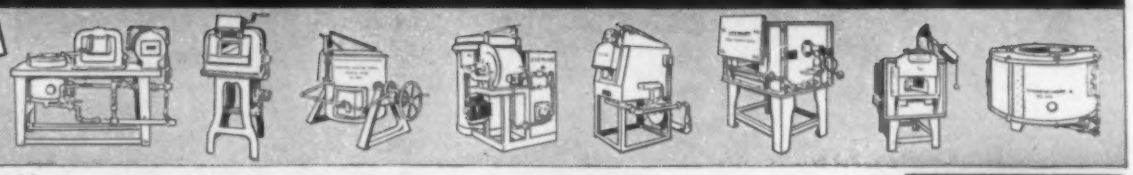
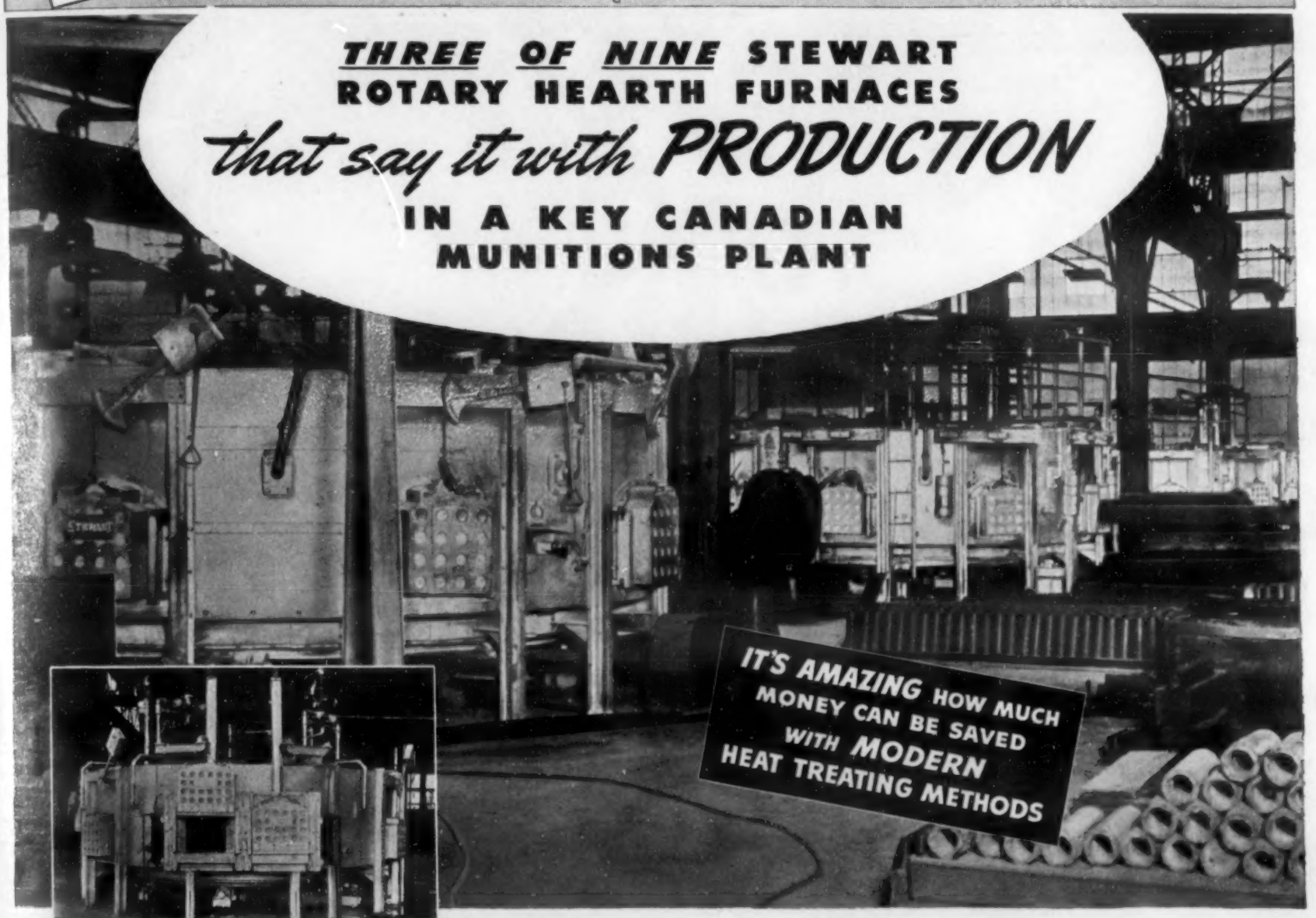


THREE OF NINE STEWART ROTARY HEARTH FURNACES *that say it with PRODUCTION* IN A KEY CANADIAN MUNITIONS PLANT



FAST, TROUBLE-FREE PRODUCTION—that's the demand of the hour in the present, "all out" ordnance program. Among the many types of industrial furnaces Stewart engineers are designing and building to meet the urgent demand for uniform production are the Rotary hearth furnaces for forging shells shown above. Stewart's circular-tunnel rotary hearth design, *sand*-sealed and friction-driven at three points has been *proven* by years of heavy-duty, 24-hour-a-day operation to be RIGHT. Multizone control plus the sand seal feature guarantees no scale troubles — and the thorough, even heat good forging practice requires. The above Rotary Hearth installation is typical of the furnaces being built by Stewart to meet the specific war requirements of manufacturers all over the continent. Stewart builds, in addition, a full line of standard furnaces.

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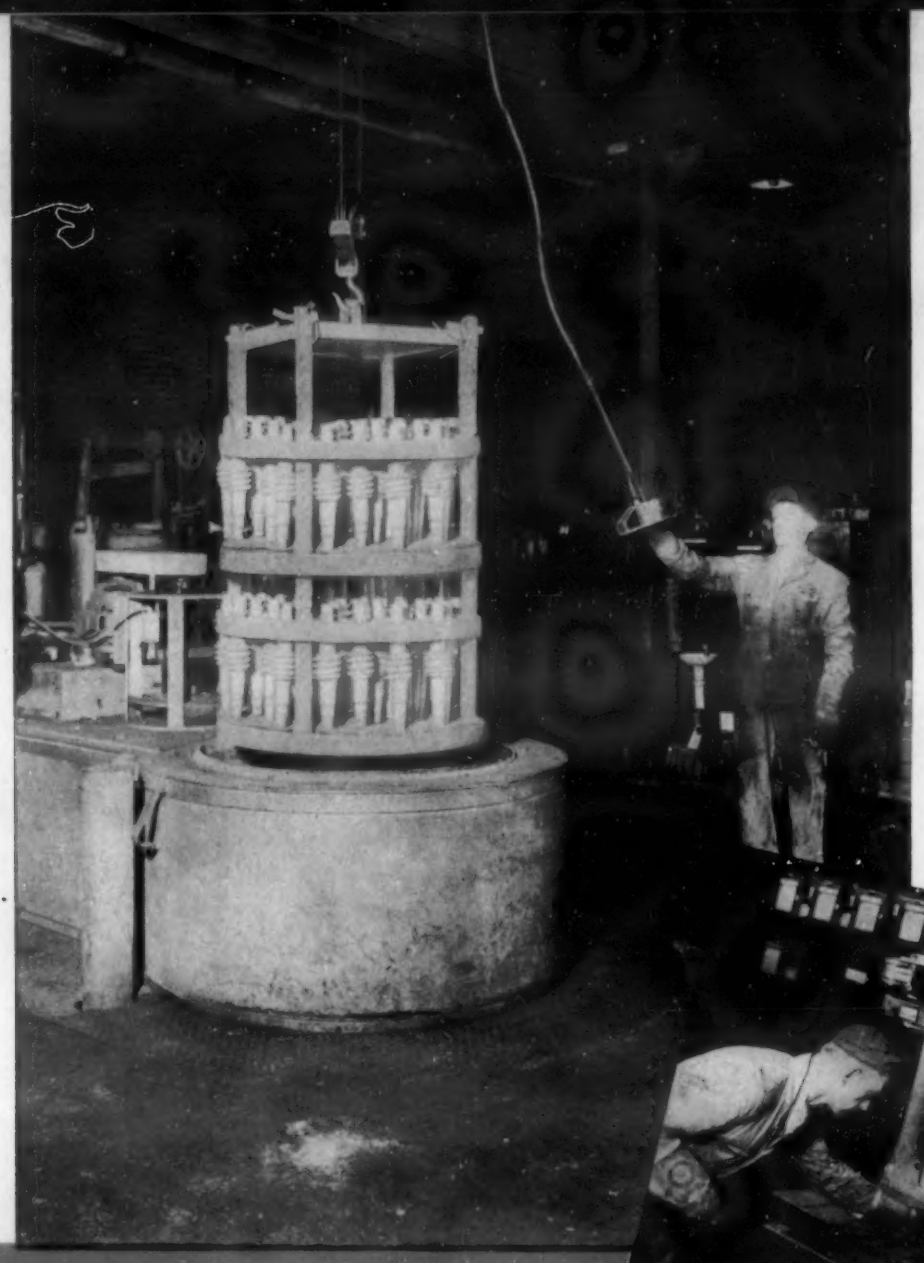


LEFT: *A load of 20 lb. worm gears being removed from a Super-Cyclone.*

BELOW: *Worm gears being heated in the Conventional Radiation Type Furnace.*

100% FORCED CONVECTION HEATING AVAILABLE FOR TEMPERATURES TO 1750° F.

Triples production . . . keeps work straighter . . . less floor space

TYPICAL OF WHAT SUPER-CYCLONE 100% forced convection heating is doing to increase heat treating production and keep the work straight is the way it goes after this worm gear job. The worms are SAE 4140, weigh 20 lbs. each, and have a maximum section of 3". They are heat treated to 45 R. C. In the Super-Cyclone, 100 of the worms (a 2000 lb. load) are placed on the fixture as shown in the above photograph, heated in a 38" diameter x 60" deep Super-Cyclone and quenched on the fixture. Previous method was to heat in a radiation type box furnace. In the box furnace, having hearth dimensions 36" wide x 5' deep, a maximum of thirty worms could be loaded at once. Time to heat the thirty worms in the box furnace was 3½ to 4 hours. Time to heat the 100 worms in the Super-Cyclone is 4 hours.

PRODUCTION TRIPLED: Floor space requirements for the Super-Cyclone and the box furnace are the same, each requiring a space 8' x 11'. The box furnace turns out 7 or 8 worm gears per hour. The Super-Cyclone turns out 25 worms per hour, or looking at it another way, 160 pounds of work per hour as compared to 500 pounds of work per hour from the Super-Cyclone. A production increase of 300%.

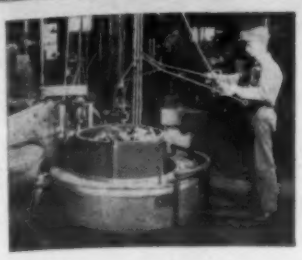
HOW ABOUT STRAIGHTNESS?

When the worms were hardened from the box furnace 85% went out between .015" and .025". Due to the high hardness of 45 R. C. straightening was extremely touchy. Straightening time per 100 worms required 8 hours time. When hardened from the Super-Cyclone, *90% of the worms required no straightening whatsoever,* and the balance was out a maximum of .010", easily taken care of in 30 minutes on the press. A reduction of 7½ hours in straightening time per 100 worms.

HANDLING REDUCED: Approximately 15 minutes were required for a man to load the box furnace. In quenching, three men handling the worms individually required 15 minutes time. A total of one man hour per 30 worms, or 3 man hours per 100 worms. Handling 100 worms in the Super-Cyclone required 15 minutes to load the fixture, 5 minutes to charge it into the furnace, 5 minutes for quenching, and 5 minutes to unload the fixture. This is a total of 30 minutes handling time per 100 worm gears or approximately 1/6 the time required for box furnace handling. It might be noted that the parts are drawn on the same fixture.

These savings are typical of what the new Super-Cyclone heating principle is doing in plants all over the country. And they are possible because 100% forced convection heating drives the heat through every part of the charge, heating every part accurately. Thus heavy loads are heated rapidly, distortion is eliminated or held to a closer range than is possible with conventional equipment. Handling is reduced so that each man in your heat treating department can turn out more work, and per unit of floor area the average Super-Cyclone installation turns out at least three times as much work as any other type of heating equipment available.

SUPER-CYCLONE FOR ANNEALING AND NORMALIZING



Heavy production in a small floor area

AT THE PLANT of a large midwestern appliance manufacturer, one Super-Cyclone 38" diameter x 48" deep anneals *twice* as many castings as the 8 box furnaces shown in the lower photograph. The Super-Cyclone requires a space 6' x 9'. The eight box furnaces occupied a space 36' x 9'. *Thus the one Super-Cyclone using but 1/6 the floor area actually doubled the production of the eight older furnaces,* or to put it another way: Super-Cyclone production was 12 times greater per unit of floor space than that of the older equipment. The reason for the Super-Cyclone's high production capacity is that the work is stacked up in the furnace, and the heat driven through the work, rather than having the work spread out over a wide hearth area to be heated by radiation.

SUPER-CYCLONE HAS WIDE RANGE OF USES

THE TEMPERATURE RANGE of the Super-Cyclone is 250° F. to 1750° F. with equal heating and control accuracy throughout the entire range. Thus it is a highly flexible unit for the small or medium heat treating department, as well as a heavy production unit for the large shop when put to work on one type of job.

Among the operations being handled by over 100 Super-Cyclones already in service are the following:

HARDENING: Typical of the Super-Cyclone's ability to turn out heavy production of touchy parts is the example shown on the opposite page.

ANNEALING: A large Wisconsin foundry is annealing and normalizing loads averaging 5,000 lbs. One Super-Cyclone 60" diameter x 48" deep turns out 17½ tons of work per day.

NORMALIZING: Because work can be stacked up densely, and quickly heated, The Super-Cyclone is an ideal furnace for normalizing.

TEMPERING: The Cyclone Principle of heating is well known to heat treaters for extremely accurate tempering under heavy production conditions. You can temper in the same furnace that you harden in with perfect heating accuracy for both operations.

NITRIDING: The Super-Cyclone fitted with a retort and cover does the same uniform job of nitriding as the standard Cyclone Nitriding Furnace. In addition, the temperature range of the Super-Cyclone enables the retort to be "cured" without removing from the furnace.

SPECIAL HEATING: Because work can be preheated at any desired rate—and cooled according to a definite schedule, the Super-Cyclone is well suited to stress relieving, spheroidizing, malleablizing and other heating operations requiring a specific cycle.

STANDARD SIZES IN WHICH THE SUPER CYCLONE IS AVAILABLE

Delivery time is speeded considerably when standard size furnaces are selected, rather than special sizes which must be drawn up. Drawings are available for the following sizes of Super Cyclones all of which have been built and are in operation. Most are gas fired, although a number are available electrically heated.

CHAMBER SIZE	CHAMBER SIZE	CHAMBER SIZE
16" diameter x 20" deep	28" diameter x 28" deep	38" diameter x 60" deep
22" diameter x 26" deep	28" diameter x 48" deep	43" diameter x 48" deep
22" diameter x 36" deep	28" diameter x 60" deep	48" diameter x 72" deep
25" diameter x 20" deep	33" diameter x 36" deep	60" diameter x 36" deep
25" diameter x 30" deep	33" diameter x 48" deep	60" diameter x 48" deep
25" diameter x 48" deep	38" diameter x 36" deep	60" diameter x 72" deep
	38" diameter x 48" deep	

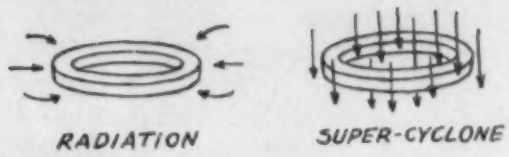
100 SUPER-CYCLONE INSTALLATIONS ALREADY IN SERVICE

IMPORTANT NOTE: Like all other Lindberg developments, the Super-Cyclone has been thoroughly proved under 24-hour a day production conditions for a minimum of 12-months before announcement to the trade. Every effort has been made to restrict the sale of these units until the probationary period was completed. In spite of this, however, many of those who have seen the furnace in operation during the past 18-months have quickly been aware of its production possibilities and requested that units be constructed for them. Thus, over 100-Super Cyclone installations are in service from coast to coast. One or more of these is near you, as is a Lindberg District Office, staffed by practical and competent sales engineers. The Super-Cyclone is *not* a cure all, nor do we represent it as such. It is speeding production, turning out straighter work, and cutting costs for many firms however, and we will be glad to survey its possibilities for you, on your work, at your request.

LINDBERG ENGINEERING CO., 2451 WEST HUBBARD ST., CHICAGO

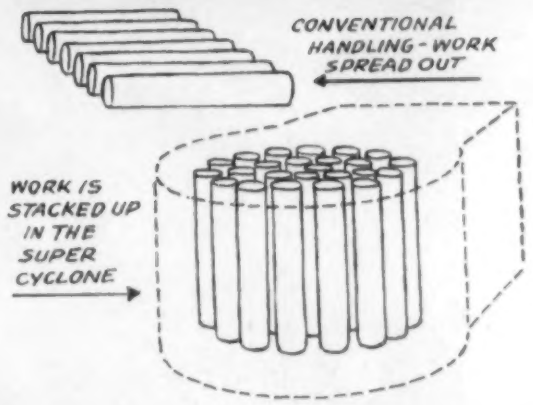
LINDBERG FURNACES

KEEPS RINGS ROUND



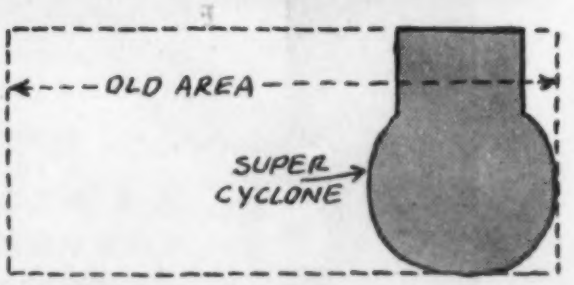
Rings, such as bearing races or ring gears, are allergic to "one-sided" heat. They go out of flat or out of round on the slightest provocation. That's why a large bearing manufacturer is enthusiastic about his first Super-Cyclone, and has ordered a second. In hardening rings 8" diameter x 3" high x 5/16" wall, quenching individually on jigs was formerly employed to hold the rings round. Now, 70 such rings are loaded onto the Super-Cyclone work fixture, heated and quenched all at the same time. The result: rings held well within the desired roundness, and heat treating time cut to ¼ of what it formerly was.

HEAVY LOADS ACCURATELY HEATED



You can easily verify the production increases possible through Super Cyclone Heating. Just spread an average load of your parts on the floor one layer thick as handled in a radiation heated furnace. Measure the area required. Then take those same parts and *stack them up* in a 36" or 48" circle, making allowance for spacers or supports. Figure it will take you a *maximum* of 3-hours to heat the piled up parts on a fixture. Five minutes to quench the lot. Ordinarily you will find production increase of from 200% to 1000% possible. Parts remain on fixture for quenching and tempering, a substantial saving in handling.

LESS FLOOR SPACE



Just measure the total floor space required to turn out your present production by your present methods. *As a very conservative thumb rule you can figure that the Super Cyclone will require not more than ⅓rd the floor area needed by any other type of equipment, to handle the same or greatly increased production.* The result... production increases of several hundred percent in present floor area . . . quick production increases without having to move or expand heat treat department area.

These thumb-rules are, of course, general and may not fit all cases. They are averages of what the Super-Cyclone has done in many plants. A Lindberg Representative can quickly and accurately give you any production figures, floor space layouts, or other information you may need.

Nickel Alloys

The results to date of a search for optimum welding conditions for spot welds of high strength, soundness and low distortion in nickel alloys are reported by W. F. HESS & A. MULLER, of Rensselaer Polytech. Inst. ("The Spot Welding of Nickel, Monel and Inconel", *Ibid.*, pp. 417s-526s). The effects of electrode size and shape were studied, the effects of temper and grain size on welding conditions evaluated, and the cause and control of porosity investigated. It is possible to produce high strength, sound spot welds in nickel, Monel and Inconel sheet by using the welding conditions recommended in this paper.

Copper alloy electrodes possessing 80% electrical conductivity are recommended for welding these materials. To insure the production of sound welds, flat (not dome-shaped) electrodes must be employed with nickel and these nickel alloys.

Close control of the energy input is essential for the production of consistently higher-stretch welds. A method of measuring the distortion produced by welding is described, and an arbitrary limit of distortion above which undesirable welds are obtained has been established. A load-distortion characteristic curve for single-spot lap-weld specimens has been obtained with the idea that such information may be of some importance in design considerations.

By decreasing the slope of the conical approach to the flat electrode face, the sticking of the electrodes to the sheets encountered when welding annealed nickel is diminished.

To aid in machine set-up, 2 shop tests were investigated. These are known as the "peel" test and the "quick section" test. It is the opinion of the authors that the peel test is of little value. On the other hand, the quick section test provides a fast, efficient method of evaluating welds made in the shop.

The same welding conditions set forth for the annealed materials may be generally applied when welding material in the ¼-hard condition. It is expected that harder materials will require other settings.

The intergranular "coring" appearing at the ends of Monel weld sections is caused by localized melting at these points. These regions should not be mistaken for cracks.

Data on the electrical conduction across metallic interfaces are reported by W. B. KOUWENHOVEN & J. TAMPICO of Johns-Hopkins Univ. ("Surface Polish and Contact Resistance," *Ibid.*, pp. 468s-471s). These indicate that when tested under the same conditions, smooth surfaces yield higher contact resistances than do rough surfaces at *low* current densities (below 2,000 amps./in.^{2}). At *high* current densities, the contact resistance of smooth surfaces falls to a fraction of that obtained for rough surfaces.

The high contact resistance of smooth surfaces is due to the presence of poorly conducting surface films of adsorbed gases or oxides. The high local intensities of pressure and current encountered in rough-surfaced contacts disrupt these films at very low values of total pressure and current. The films then play no role in subsequent operations. With smooth surface, however, the films are little affected by pressure alone, and a high contact resistance exists until the films are disintegrated by a high current density. WB (2)

Specify

R-S FURNACES

A PLEDGE AND A PROMISE

Designers and manufacturers of a diversified line of heat-treating furnaces since 1908, R-S pledges full support of the all-out production effort so that Democracy and our free way of life may survive. Now is the time when specialized experience and speed can best serve the common goal of supremacy over aggression.

Steel and other metals for the implements of war must be heat-treated. R-S Engineers are specialists in the manufacture of heat-treating furnaces — furnaces that are designed for every heat-treating operation and for uniform, peak production. Previously arranged plans permit of surprisingly fast deliveries.

For the speedy solution of emergency heat-treating problems, R-S promises full cooperation for the duration.

Call on experienced R-S Engineers.

R-S PRODUCTS CORPORATION
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R-S QUALITY PRODUCTS SINCE 1908

R-S FURNACES OF DISTINCTION

Effective Use of Cutting Tools

"GETTING THE MOST OUT OF CUTTING TOOLS." ROY T. WISE. *Tool Engr.* Vol. 11, Jan. 1942, pp. 47-53. Practical.

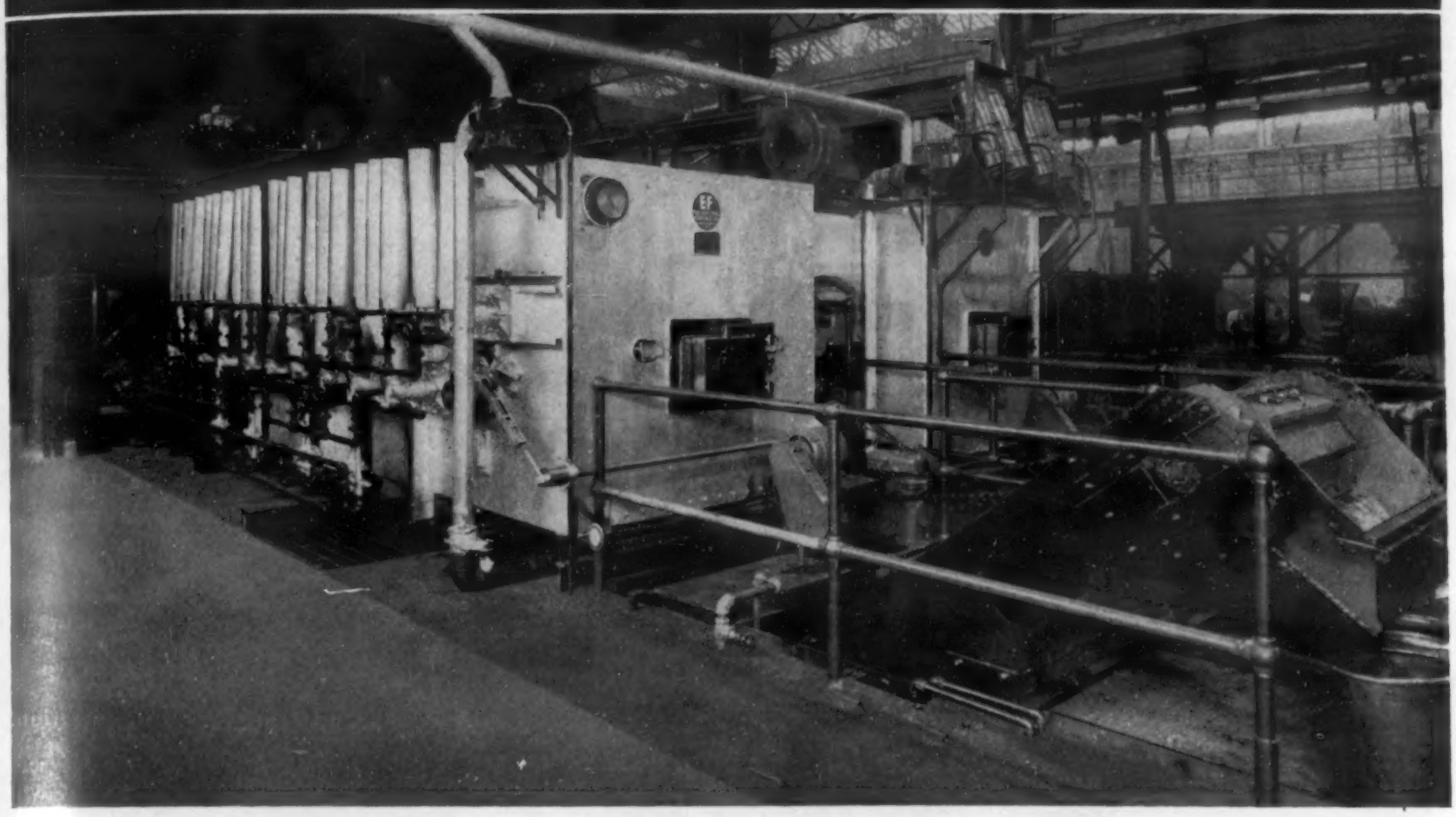
The best melting machine in the world is a liability without suitable cutters, properly sharpened. Three factors are important in getting the most out of cutting tools: selection of the right tools; proper sharpening and maintenance; and correct application to utilize the maximum productive capacity of the machine.

The use of the right grinding wheels for sharpening cutters is important. Photomicrographs of cutting edges are presented to show that a cutter, even though correctly designed (spiral flute of 45°, rake angle back of the cutting edge, etc.), and sharpened with the right grinding wheel, will suffer if the wheel is dressed with the wrong type of stick.

For example, some sticks transfer their irregularities into the face of the grinding wheel and thence to the cutter tooth. The high points on the latter will break off early, and the cutter produce only, say, 20 pieces before needing resharpening. If the wheel be dressed with a dull diamond, the between-resharpening production would be raised to 60 pieces. If a sharp diamond be used, set at an angle of 20° with a sharp corner, high points on the cutter tooth do not appear, and production will be lifted to 200 pieces.

An ideal cutter tooth design has a small land with enough clearance to allow the right feed to be used on the machine. Height should be about equal to the root

Now is the time to GET THE MOST OUT OF EVERY B.T.U.!



Here's why heat losses are cut to a minimum with Armstrong's Insulating Fire Brick

TODAY, maximum production is vitally important. In heat treating equipment Armstrong's Lightweight Refractories will help increase capacity. Three qualities of Armstrong's Insulating Fire Brick help furnaces to operate at peak efficiency:

HIGH INSULATING EFFICIENCY: Armstrong's Brick aid in the uniform distribution of heat throughout the furnace, permit more flexible temperature control, and effectively reduce fuel costs.

LOW HEAT STORAGE: The low weight of Armstrong's Brick provide faster heating and cooling in intermittent type furnaces. This permits more cycles per day and with less fuel per cycle.

HIGH PHYSICAL STRENGTH: With Armstrong's Brick, strength has not been sacrificed to attain light weight and low conductivity. Every type is highly resistant to spalling and has exceptionally high crushing and breaking strength (hot and cold), as well as ample refractoriness for the use intended. Ability to stand up in service means less time lost for maintenance and repairs.

Armstrong's Brick reach the job in good condition and lay up quickly. They are made in special shapes to order and in standard sizes which are easily notched, grooved, and shaped right on the job.

For engineering service and facts about the five types of Armstrong's Insulating Refractories for temperature ranges from 1600° F. to 2600° F., write now to Armstrong Cork Co., Insulating Refractories Dept., 982 Concord Street, Lancaster, Pa.

THIS ELECTRIC FURNACE COMPANY unit heats 1,500 lbs. of steel per hour to 1550° F. It is a gas fired, recuperative, radiant tube type furnace for scale-free and commercially "decarb-free" hardening and drawing. It is lined with Armstrong's Insulating Refractories.

★ ★ ★

section and there should be ample chip space to avoid clogging in the flute. A large proportion of broken small cutters fail because of lack of chip space in the flute. In most cases, there are more teeth than necessary in these small cutters.

Rake angle on the face of a tooth, if properly ground, can increase the effectiveness of a cutter at least 75% on some materials. The spiral flute for most cutters a few years ago was about 20°, without any rake. A spiral of 30° is now applied to most end mills, with a 10° rake. The maximum possible feed with the old design was 5 in./min.; with the new it is 18 in./min.

Most standard cutters manufactured today are 63-64 Rockwell C; some special cutters run as high as 65 Rockwell C, but, generally, this should be the maximum. Cutters under 63 Rockwell C have little value today. FPP (2)

Insulating Firebrick

"Insulating Firebrick in Modern Furnace Construction," N. Allen Humphrey (Johns-Manville) *Blast Furnace & Steel Plant*, Vol. 29, Dec. 1941, pp. 1197-1201. Practical.

In periodic-operating furnaces, such as those used for heating for forging, heat treating, etc., losses due to heat storage within the walls become a greater factor than heat transfer through the walls.

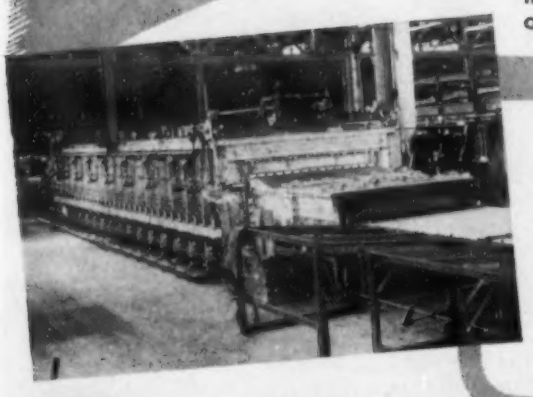
About ¼ as much heat is required to establish equilibrium conditions in an insulating firebrick wall as would be required in an ordinary firebrick wall of the same thickness. Insulating firebrick walls come up to the operating temperature in much less time than regular firebrick under the same firing conditions, resulting in saving much time and fuel in furnace operation.

As an example of selection of the most economic furnace wall construction, a comparison of 9-in. walls demonstrates that a wall of 9-in. insulating firebrick and 1-in. block insulation provides very good economy and affords the best construction. While 9-in. insulating firebrick shows only slightly better economy, the insulating block offers broken joint construction, which is conducive to a good tight furnace wall structure, and is, therefore, the standard recommended.

Even with less complete cooling during the shut-down period, the insulating block affords a good return on the investment. The insulating firebrick must possess the refractory qualities of the better grade of firebrick. Although it entails a somewhat foreshortened life, the use of insulating firebrick is economical. MS (2)

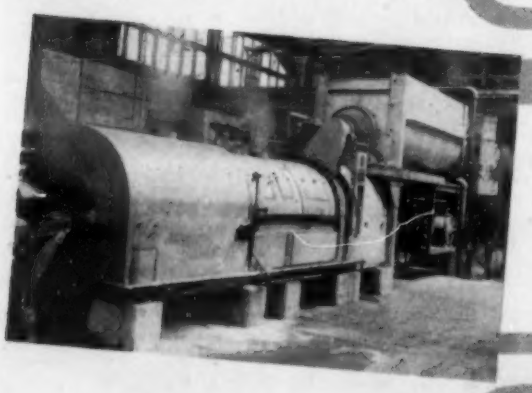
FURNACES THAT SAY IT WITH PRODUCTION

In the heat treatment of shells and other defense products, Rockwell Furnaces speak for themselves. Here are several of the many types that say it—convincingly—in terms of production.



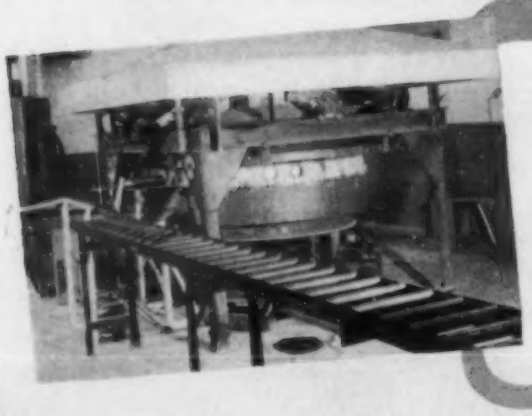
18,000 LBS. PER HOUR

This Gas Fired Roller Hearth Annealing Furnace handles cartridge brass slabs. Construction is unusually rugged — the rolls are extremely heavy, and the drive and all other parts are capable of this extreme production rate. Driven rolls carry the slabs from the charging table through preheating, heating and cooling sections, and on the discharge table to the dump mechanism.



3,000 LBS. PER HOUR

A Gas Fired Revolving Annealing Furnace (Retort Type) that is a complete unit for washing, annealing and pickling 50 caliber brass cartridge cups in a continuous, even stream. A great producer, it is also exceptionally economical from the standpoint of labor, fuel and in the use of acid.



70 SHELLS (4.5") PER HOUR

A Revolving Hearth Type Shell Nosing Furnace with openings around its outside circumference for receiving the shells. Heating is so controlled that no distortion occurs below the taper during the press operation. Charging and discharging from the same position requires only one operator—shells being sent to him on a conveyor. The absence of a water-cooled chill results in a great saving of fuel.

Because of standards already established, time-saving deliveries can be made on many types of Rockwell Furnaces that will step up your production. What is your heat treating problem?

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL CO.

50 CHURCH STREET NEW YORK, N. Y.

Radiant-Cup Gas-Firing for Heat Treating Furnaces

"Small Radiant Cups Direct Heat to Work." F. O. Hess (Selas Co.) *Metal Progress*, Vol. 41, Feb. 1942, pp. 217-220. Descriptive.

The discovery that most combustion spaces are much larger than is necessary has led to the development of a new method of gas-firing of industrial heating furnaces. Several hundred installations of this new type of radiant gas burner have already been made, involving 35,000 burners of special shape.

The principle may be called "muffle-less, radiant-cup, gas-firing." The gas-air mixture burns from a multiplicity of radial slots in a refractory tip, along and in contact with the surface of a refractory cup designed to follow the natural sweep of the individual flames.

Thus, the cup surface becomes highly incandescent, so that it (a) constitutes an effect source of radiant energy; (b) accelerates the gas-air reaction so that surprisingly high rates of heat liberation in a small space are achieved; and (c) insures complete combustion before any gases pass beyond the face of the cup into the work chamber.

The limitations on cup surface temperatures attainable seem only to be flame temperature and the heat resistance of the refractory (the burners are now made in special refractory mixes and designs developed by the author's company). An added benefit is the carrying of convected heat in products of combustion that do not blast or channel. Flame impingement is eliminated, and combustion is complete. The independently controllable radiant-energy sources can be arranged in almost any pattern and number over any furnace roof, wall or shell, achieving very large, highly efficient and adjustable radiant sources.

One practical benefit has been the elimination of the "fly wheel" effect in furnace firing. In conventional methods, where the furnace walls are a major heat source, changes in furnace temperatures cannot be made to follow rapidly changes in gas input. Where the radiant cups do the heating, however, adjustments can be very rapid.

Among the processing now being done in furnaces fired by radiant cups are heating of oxygen cylinders and bomb casings; annealing high-chromium wire; continuous heat treatment of cast tank hulls; bright annealing of copper; continuous annealing of armor plate, etc. FPP (2)

Rubber Press Tools for Forming

A Composite

The advantages of using rubber pads as part of the die set in press forming sheet metals are well known to many engineers, particularly in the aircraft industry, where the Guerin process is widely used—sometimes in conjunction with soft metal dies. In addition to notable savings in die costs, the process is responsible for much faster production, and in many shops has facilitated the production of several different stampings within a few moments of each other on the same press.

[*Manifest advantages of engineering advances are not always evident to politicians or to picture-magazine editors. In its Jan. 26th issue, "Life" pictorially followed "shrewd, foxy-faced" Senator Truman around while he gathered data for the Truman Committee report. Said "Life" in one caption: "Committee report charged that the aviation industry still employs old and wasteful methods. . . . Some use rubber and soft-metal dies instead of efficient steel." Say we: "Phooey!"*—F.P.P.]

Two recent articles in a British magazine have furnished some interesting descriptive details of the use of rubber in press forming. In the first, by F. L. JOYCE ("The Use of Rubber in Conjunction with Press Tools," *Machinery (London)*, Vol. 59, Oct. 9, 1941, pp. 29-32) technical requirements for use of the process are discussed.

The process is economical, since many parts are usually formed at once, and the amount of energy required is governed solely by the effort necessary to accomplish the work where the least effective area is available. It is ideal for forming flanged holes, etc.; while small bends and turnovers are most difficult. If flanges and lips are to be formed in different directions, either a double operation is necessary, or an auxiliary rubber bed must be used.

The best practice calls for bending by external rather than internal pressure and forming over projections rather than into a recess. Generally, the thicker the rubber is, the better; 6-10 in. is the usual size range, with 10 in. preferred if a double rubber bed is to be used, in which case the secondary bed is 3-4 in. thick.

The friction or adhesion between the metal being worked and the rubber is avoided by dusting the metal with French chalk or very fine abrasive powder. Care should be taken that no scale or small pieces of metal adhere to the rubber, as such particles would have a very deleterious effect on subsequent work.

A later article describes many operating factors in the use of rubber dies ("Operations with Rubber Dies," *Ibid.*, Dec. 4, 1941, pp. 253-258). Hydraulic presses are best suited to the use of rubber dies.

The rubber pad is housed in a steel container with the thickness of the rubber about ⅔ the depth of the container. Preferably the platen moves up into the container so as to form a confined space with the sheet metal between the dies and the pad. As the pressure increases, the rubber first fills all the space, then it is compressed so as to form the metal blank. This method has several advantages, including the fact that only one die is required, and the fact that the sheared edges are smooth.

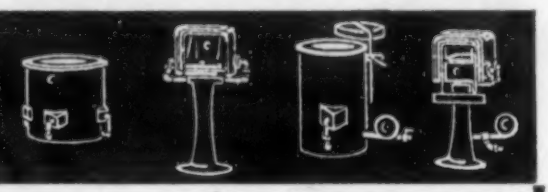
The useful life of the rubber is extended if it is entirely confined within the container during all operations. The hardness of the rubber is a function of the depth of pressing: Shore 75 is satisfactory for flanging, beading and forming stiffening ribs, while Shore 55-60 is better for deep drawing 4-6 in.

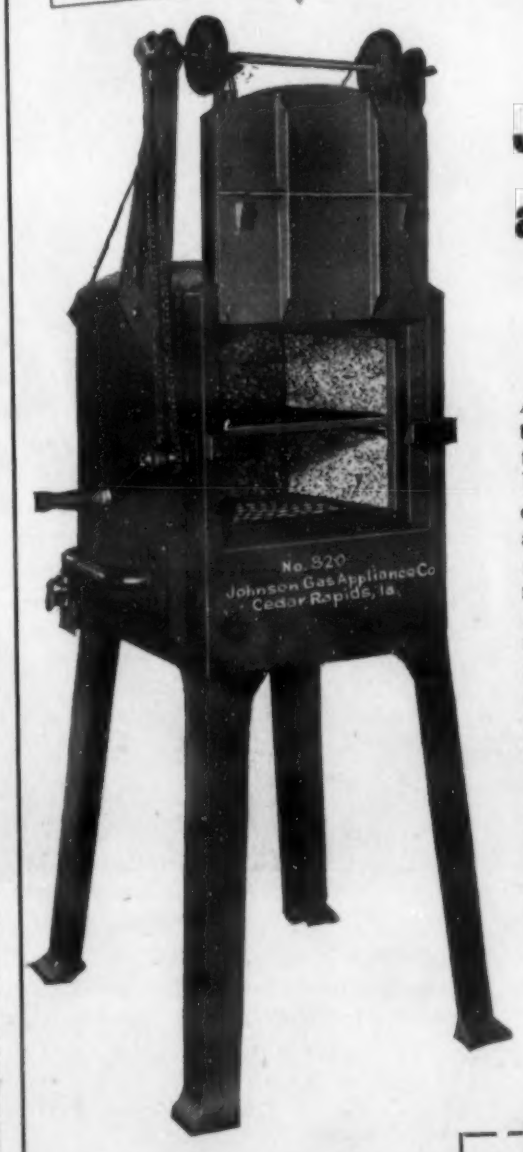
The rubber pad is often built up of a series of laminations 1.5-2 in. thick, although now one-piece pads are available, which are mechanically more sound. Since these pads weigh 2-3 tons, they must be securely attached to the container. A backing plate is covered with a large number of holes perforated to about ⅓ the thickness of the plate. The rubber is then forced into these holes and vulcanized.

Too smooth a rubber surface is not desirable, as there will be difficulty with it adhering to the platen. If the rubber pad is damaged, it can be repaired by grinding away the damaged portion, filling with uncured rubber, and vulcanizing under pressure. Nine in. is a suitable thickness for general forming, flanging and shallow drawing.

The pressure depends upon the application. With magnesium sheet, a suitable time control cycle of pressure is required. Aluminum, especially alclad, sometimes gives difficulty with dragging in steel dies, but this is entirely eliminated with rubber. A lubricant should be used for all drawing operations. Oil or grease is to be definitely

New JOHNSON Furnace ON THE OFFENSE





Keep 'Em Burning!

JOHNSON TEMPERING and DRAWING FURNACE No. 820

A new Johnson Furnace, ready to go to work for you on any job requiring temperatures from 275 to 1200°F.! Use it for speedy tempering of tools, dies, small parts, non-ferrous castings and parts, for heating aluminum forgings and rivets. It's a compact unit, requiring little floor space, and is easily moved. It's built to stand up under today's—and tomorrow's barrage of duty! Heavily lined with insulating refractory, and equipped with 2 large Johnson atmospheric burners, placed so they give remarkably even heat thruout the combustion chamber. Counterbalanced, self-aligning door is well insulated to reduce heat loss, and is controlled by crank. Two Allegheny metal shelves hold parts to be treated. Firebox, 16" wide, 16" deep, 14" high. Equipped with automatic temperature control at extra cost. Write for full details and prices.

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ONE

Steel-Hardening Process Stands Out in this Emergency

CHAPMANIZING

"Times and conditions often select a great leader". And that's what has happened in the metal-working industry, where the searching tests of war requirements have singled out a process for surface-hardening steels . . . the quick, inexpensive and super-durable process long known as Chapmanizing.

Chapmanizing gives steel parts a tough yet ductile case from .002" to .035" deep . . . in 1 to 4 hours of hardening time. Chapmanizing turns out parts that are silver-clean, free from soft spots, with a wear-resistant surface that won't chip, warp, distort or corrode under bending, abrasion or sliding pressure. And Chapmanizing gives free-machining steels the wearing qualities of scarce and costly alloys, where specifications permit substitution.

And if *your* specifications permit, it can be arranged for you to ship any material either to the Chapman plant or the nearest Chapman licensee . . . and get the full benefits of this modern hardening process. Write to the Metallurgical Sales Division of:

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CHAPMAN VALVE

MANUFACTURING CO.

Indian Orchard, Mass.

Combustion chamber and burner ports of Refractory Concrete, made with LUMNITE. Chamber is 15 ft. long, 9 ft. wide, 6 ft. high. One of 3 installations in gas-fired boilers of R. Herschel Mfg. Co., East Peoria, Ill.

Refractory Concrete, made with LUMNITE, writes a notable record of savings and service for the R. Herschel Manufacturing Company

THE picture above shows the combustion chamber and burner ports of one of three gas-fired boilers installed at this East Peoria, Illinois, plant. Refractory Concrete, made with LUMNITE, has been in service for over five years and is still in excellent condition.

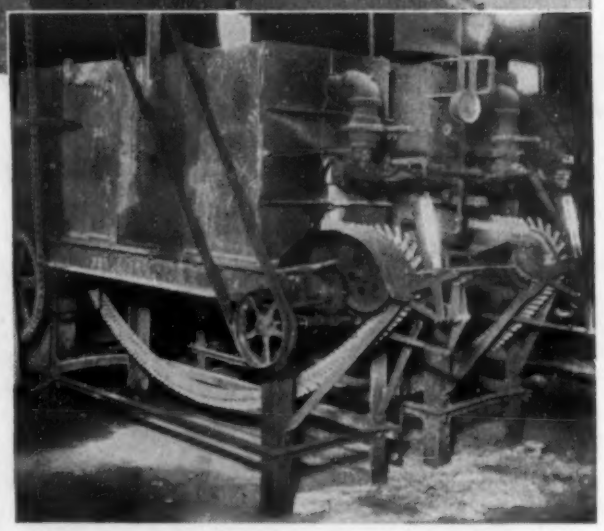
Ten years ago the Herschel Company used its first Refractory Concrete in small furnaces. Economy in first cost and low maintenance figures led to installation after installation. And you hear reports like these: "Saved 50% on refractories" . . . "Forge furnace for blacksmith shop built at ½ usual refractory cost" . . . . . "40% saved on first cost plus greater service life."

Here are some of the Refractory Concrete installations in the Herschel Company plant today:

1. Combustion chamber and burner ports in 3 gas-fired boilers.
2. Parabolic curved roof arch, walls and hearth in 6 gas-fired tempering furnaces.
3. Hearth, walls and roof arch of blacksmith shop heating furnace.
4. Slabs for well-type blacksmith heating furnace.
5. Variety of special precast shapes.

This story of the successful use of Refractory Concrete, made with LUMNITE, is only one of many. There are 7 good reasons why you will find it efficient and economical.

You can get LUMNITE from dealers all over the country—and in Canada. Send for detailed information in the booklet, "Refractory Concrete." Atlas Lumnite Cement Company (United States Steel Corp. Subsidiary), Dept. M, Chrysler Bldg., New York City.



One of 6 tempering furnaces, all lined with LUMNITE Refractory Concrete. Only one of many uses of this refractory by R. Herschel Manufacturing Company.

Lumnite Castables

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Here's a quick, easy way to make Refractory Concrete for many jobs. Get factory-prepared mixtures of LUMNITE and selected aggregate, and just add water. These LUMNITE Castables are obtainable from refractory manufacturers and their distributors. They have the regular properties of Refractory Concrete—quick-hardening, high cold strength, sustained strength in service.

Specify Castables "Made with LUMNITE"

LUMNITE FOR REFRACTORY CONCRETE

avoided; dry lubricants such as graphite or powdered French chalk are satisfactory.

Die blocks may be made of seasoned hardwood in layers about 1.5 in. thick, glued and screwed together to give the desired depth. A ⅛-in. steel plate protects the edges of the die. How often intermediate anneals must be used is a function of the application and must be determined entirely by trial. JZB (2)

High Production Heat Treating

"Furnaces for Production Heat Treating." R. Le Grand (Staff) *Am. Machinist*, Vol. 85, Dec. 10, 1941, pp. 1256-1259. Practical.

Rotary hearth furnaces have high productivity for operations such as heating billet steel before piercing for shell, heating shell prior to nosing, gear hardening, heat treating, etc. Each furnace is generally designed to handle one type of work rather than for universal application.

Either the entire furnace is revolved past stationary burner equipment, or only the hearth is rotated. Unit loadings per ft.² of hearth area may vary from 20 lbs. for tempering to 85 lbs. for forging. Heating is uniform. Early faults such as warping, choking with scale, and wedging of work between rotary and stationary elements have been eliminated by improved design.

Rotary retort furnaces are continuous heat treating machines which do not require an operator for feeding, since a quantity of work is charged into the hopper, which gradually feeds the work into the retort. These furnaces generally handle 75 to 1400 lbs. of work/hr. and can be used for gas carburizing, annealing, normalizing, and clean-hardening.

Batch type furnaces are being used to an increased extent, since the heating cycle can be planned to secure the most efficient expenditure of labor: Batch car type furnaces are built in any required size for annealing or normalizing locomotive frames, gun mounts, etc., while brass cartridge cases are stress relieved in such furnaces where production is not sufficient to warrant continuous equipment.

Bell type batch furnaces may be rectangular (usually for annealing or normalizing long bars or bundles of sheet) or round (coils, or baskets of forgings). The heating elements are in the bell part, which is lowered over the charge on a base. It is customary to use two bases for each bell, so that one base can be loaded while the other is in use. An alloy steel hood can be placed over the charge so that it is protected from the air when the bell is removed to the other base.

Pit furnaces are now often used for heat treating gun jackets and tubes, shrinking operations, etc. Box furnaces are widely used where large quantity production is not essential. This type can be used with or without protective atmosphere.

Pot type furnaces are batch furnaces used for hardening, annealing, or gas carburizing small parts in quantity. Dense loads of small parts can be properly heated by use of the convection principle.

Elevator type batch furnaces may have 1 or 2 chambers. The 2-chamber design is used for operations such as annealing malleable iron castings, where low and high temperature chambers give an economy approaching that of continuous furnaces. The single-chamber furnace is used in the aircraft industry for heat treating aluminum alloy sheets where rapid heating is essential and temperature must be closely controlled. Sheets are suspended from a special rack and are automatically quenched from the furnace. JZB (2)

Induction Brazing of War Products

"Induction Brazing in Ordnance Work." W. E. Benninghoff (Ohio Crankshaft Co.) *Steel*, Vol. 109, Dec. 29, 1941, pp. 58, 60. Descriptive.

Brazing using electrical induction as a heating medium permits increased brazing speeds; localized control of the heat to the area to be brazed—within 0.25-in. limits; precise duplication of results on all parts; uniformly brazed joints; lower unit cost of work done; and operation by unskilled labor after heating cycle is established.

Any composition of metal that can be brazed can be heated inductively except perhaps 2 extremely thin sections which by their shape do not lend themselves readily to induction heating. Strength of inductively-formed joints is equal to the strongest unions. In tensile tests of an assembly of two tubes inductively brazed with silver solder, the tubes broke without failure of the brazed joint.

Induction heating often can be applied easily and successfully where it is impossible to apply heat by usual methods to the inside of a joint, or whenever a part is unsuited for furnace brazing. The principle of induction heating applied to brazing is the same as when applied to surface hardening, except for elimination of the quench and the use of a different heating cycle.

Brazing fixtures and water-cooled inductors are readily designed to fit almost

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HERE'S a big capacity separator incorporating *two* High Intensity Dings Magnetic Pulleys for removal of iron from non-ferrous turnings, borings, etc.

1. Scrap is fed through a hopper onto an endless belt. Suspended above it is another endless belt and a Dings Pulley which lifts out iron and discharges it. ***Separation point No. 1.***

2. Separated material passes on under the first pulley and over a second Dings Pulley, where any remaining iron is removed. Non-ferrous metal discharges to a suitable receptacle. ***Separation point No. 2.***

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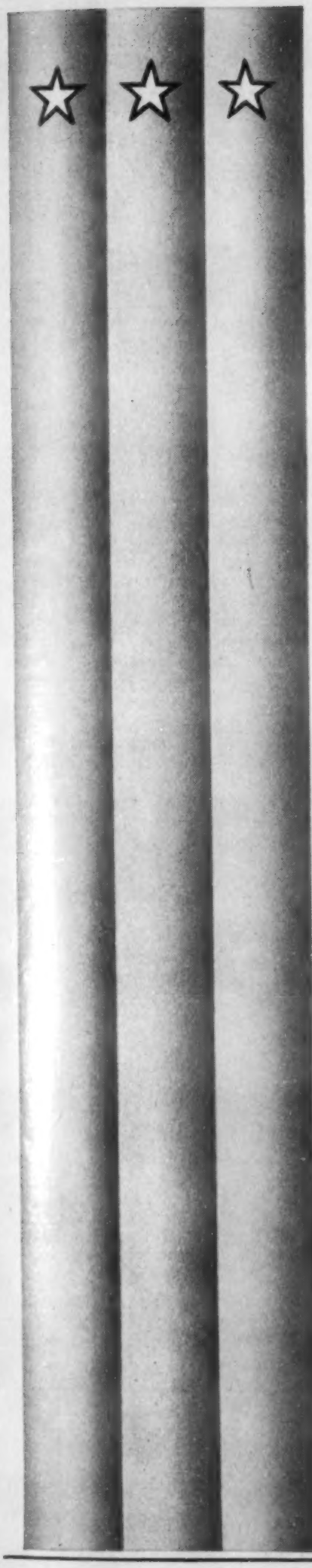

for SELECTIVE CARBURIZATION

Use Du Pont

HIGH SPEED COPPER

MANY of the steel parts used in making tanks, guns, airplane parts, trucks and other defense items require selective hardening in order to meet the exacting specifications. Usual practice is to stop-off carburization by copper plating the portions which are to remain soft. The success of the subsequent localized hardening, however, is generally dependent on the effectiveness of the copper deposit.

The High Speed Copper plating process is particularly suitable for this type of work for:

1. ***The solution has excellent throwing power.***
2. ***Base metal is not attacked.***
3. ***Fine-grained, uniformly distributed, non-porous deposits are readily obtained.***
4. ***Thin and thick coatings are produced quickly and easily.***
5. ***Plating time is about ¼ of that required for older types of cyanide plating.***

With this process, it is possible to produce consistently, smooth impervious copper deposits of the required thickness and uniformity. Deposits of this kind are essential requirements for stop-off work. Rejects can be minimized — an important feature in economical and speedy production of airplane and other parts.

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any part. Establishing the correct heating cycle for a particular job is a routine matter. A self-contained induction brazing unit includes motor-generator sets with outputs up to 100 kw. for producing alternating current at a frequency of 10,000 cycles, inductor, suitable transformer and capacitors, and automatic timing controls.

Induction units are brazing the adapters on 75- and 105-mm. chemical shell bodies, with the heat being restricted to a ¼-in. wide band on either side of the joint. The brazing alloy, formed to fit the shell, is placed over the nose. The adapter is screwed into place after the flux has been applied. The shell is placed nose down in the double inductor of a 2-station 20-kw. unit.

Two shell bodies are brazed simultaneously while the operator is setting up 2 more in another station. A brazed shell is turned out every 20 sec. A similar unit brazes 300 burster tube assemblies per hr.

In the aircraft industry, induction brazing by unskilled labor is being used on tubes, flanges, fuselage parts, and engine accessories. Formerly, a certain part was brazed by hand at the rate of 5 per hr. Now, it is being brazed inductively at the rate of 20 per hr.

Other applications are bed ends composed of a tube, case and cap; industrial brush assemblies in 15 sec.; and silver soldering of carbide tips to tool shanks in 1 min., 56 sec. on a 40-kw. unit. Preliminary results of tests on the brazing of aluminum indicate that satisfactory results will soon be achieved. MS (2)

The ENGELHARD FLUALYZER provides a new, industry-proved method for testing burner efficiency of either oil or gas fired atmosphere type heat treating furnaces by determination of CO_2 percentage . . . The instrument is easy to use and fast, accurate determinations as to the oxidizing, neutral or reducing condition of the gases can be made by totally unskilled operators.

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Write for details and specific application data.

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2a. Ferrous

Additions to Hot Galvanizing Baths

ALLOYING ADDITIONS TO HOT GALVANIZING BATHS. PART II. INFLUENCING THE IRON SOLUBILITY ("Die Legierungszusätze zu Feuerverzinkbädern. Teil II. Be einflussung der Eisenlöslichkeit") H. BABLIK & F. GÖTZL. *Korrosion und Metallschutz,* Vol. 17, Apr. 1941, pp. 128-130. Research.

The mechanism of the formation of alloy layers on iron and the manner in which the alloying additions influence the solubility and diffusion of iron in zinc are discussed.

Hot galvanizing is usually carried out at bath temperatures near 925° F. Galvanized structures can be distinguished according to their formation below or above this temperature. Below this temperature, reactions will occur only with the material to be galvanized, while above 925° F., in addition (and principally) reactions have to be considered, which affect the life of the galvanizing tank.

The investigations show that under all practical conditions up to 875° F. the iron solubility is not appreciably changed by the usual alloying additions, except aluminum. For temperatures above 925° F., the life of the galvanizing tank is not affected by small additions of copper; additions of lead and tin are not good; additions of antimony, and particularly cadmium, are very harmful.

These bad effects above 925° F. are ascribed to the formation of a protective zeta-phase, which (in the presence of these additions) is formed at temperatures lower than the galvanizing temperature and then transformed into a delta phase at higher temperatures. The existence of the zeta phase is the reason for the negligible influence of alloying additions below 925° F.

The peculiar effect of aluminum has not yet been explained. The foregoing summary of the second part of this important article is of necessity sketchy, since the issue of *Korrosion und Metallschutz* containing the first installment has not been received. Much of the information in the second installment cannot be understood, transcribed and abstracted without explanatory definitions and legends evidently published in the first part. MH (2a)

Welding Clad Steels

"WELDING OF CLAD METALS." G. RICHTER. *Metallwirtschaft,* Vol. 19, 1940, pp. 267-276; in German. English translation in *Sheet Metal Inds.,* Vol. 15, Nov. 1941, pp. 1427-1434; Dec. 1941, pp. 1258-1260. Research with voluminous data.

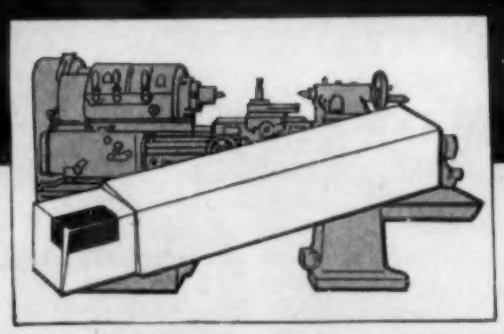
Tests were made on flat sheet and 20-in. diam. cylinders, with a cladding thickness of 0.02 in.-.08 in. The welding methods used are given in the Table.

	Method of Welding	
Cladding	*Basis Material*	*Cladding*
Copper	electric	oxyacetylene
Nickel	electric	electric
Nickel	oxyacetylene	oxyacetylene
18-8 Stainless	electric	electric
Remanit 1880*	electric	electric

* Analysis not given, but hardenable chromium stainless.

Tensile and bending tests on welded samples showed that joints made with different forms of weld and with different welding methods can all be regarded as equivalent. Repeated-tension fatigue tests showed a number of scattered values which seemed to be due more to misalignment of

WHICH CAME FIRST?



CUTTING TOOL? **MACHINE TOOL?**

The answer is easy when applied to the cutting tool vs. the machine tool.

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TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER

BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

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sheets than to small pores, defective bonding, etc.

Corrosion tests were made as follows: Copper-clad steel was exposed to sea water and to tap water containing carbon dioxide; nickel-clad steel to concentrated caustic soda; 18-8 stainless clad steel to sulphite liquor at 280° F.; and the Remanit-clad steel also to sulphite liquor at 280° F. In each case comparisons were made with material similar to that of the coating. The behavior of the clad metals and of the welds therein was about the same in these tests as that of the comparison material.

The amount of iron diffused into the coating was checked chemically and by ferroxyl porosity tests. The results indicate that it would be advisable to clean the surface of the coating either mechanically or chemically after welding.

Although the nickel-clad material had high iron contents in the welds (up to 9%), this iron did not seem to have any deleterious effect on the corrosion resistance. In the case of the nickel-clad sheet, electric welding and oxyacetylene welding were equivalent except that the oxyacetylene welding was superior in regard to iron content in the weld; nevertheless, electric welding is recommended by the author. Radiological and metallographical examination of the bonds gave substantially the same results.

Scarcely a single intersection weld was free from defects, therefore such complicated welds should be avoided if possible. Otherwise, the union between weld, coating, and basis metal was good in practically every case. Pores and bonding defects can be avoided satisfactorily only if the root of the iron weld is carefully ground out before the application of the coating weld. Chipping and brushing is not always adequate.

JZB (2a)

2b. Non-Ferrous

Forming Zinc Extrusion Alloys

"The Forming Properties of Zinc-Base Extrusion Alloys." A. Burkhardt. *Metal Industry*, Vol. 59, Dec. 26, 1941, pp. 402-404. Translated from *Metallwirtschaft*. Research.

Zinc-base extrusion alloys have the peculiarity that under mechanical stress they will commence to flow at points of weakness, and will undergo considerable change of section at such points without fracturing. At these points, a very considerable reduction in cross-section may take place before breakage occurs.

It seems contradictory to find a material which, after drawing, shows a decreased resistance to plastic deformation and a fivefold increase in elongation figure, and yet which cannot be drawn down further. The reduction in area figures gives no explanation of this either.

The mechanical properties of zinc alloys with 10% Al and 1 Cu are hardly altered by drawing. The elongation certainly improves but does not show the striking increase met with in the case of the 4% Cu alloy. The drawing qualities are exhausted at 80% reduction in cross-section. The work of plastic deformation remains more or less the same with increasing cold work. The value in the raw extruded condition is appreciably lower than that for the 4% Cu alloy in the same state.

The effect of heat treatment is particularly marked. The ordinary tensile values show only small changes while the work of plastic deformation reaches a well-defined maximum after heat treatment at 480° F.; with excessive reductions, the exhausted drawing qualities cannot be revived by

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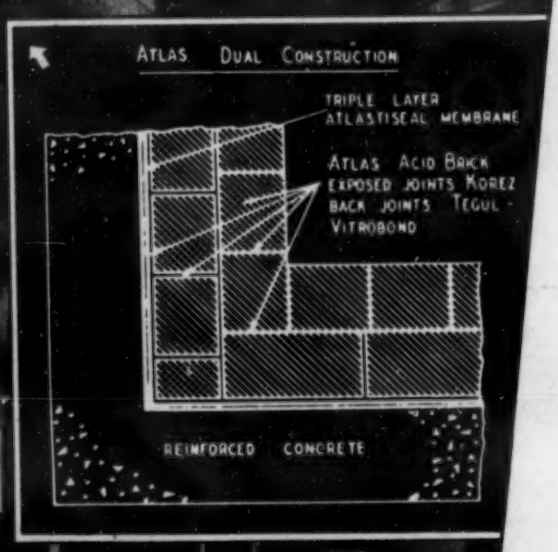

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This No. 2 Type "C" Horizontal Electric Heater is designed to develop heat in the piece that is to be soldered, to such temperature as is necessary to melt the kind of solder used. For example, if you want to solder a mercury tube to the gage body, the gage body would be placed between the electrodes of this BERWICK Heater, brought up to 350° if soft solder is being used, or to 1350° if silver solder is used. The same is true where discs are to be soldered in the ends of brass or other metal tubes . . . or where the brass, copper or other metal slugs on which threads are cut are to be soldered in the tubes or other articles. A cleaner, stronger soldered joint is secured.

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heat treatment because the material is overdrawn.

Therefore, the elongation at fracture and the reduction in area figures obtained with zinc-base alloys cannot be used as a means of measuring their forming qualities. On the other hand, the work of plastic deformation calculated from the tensile test diagram does form a reliable basis for assessing their working properties. As a result of this, and contrary to existing opinion, intermediate annealing is beneficial after 30-50% cold reduction has been performed on zinc-base alloys.

The optimum annealing temperature varies with different alloys. The best annealing temperature for the copper-bearing alloys is from 575° to 660° F.; for the zinc-aluminum-copper alloys, 480° F.; and for the zinc-aluminum alloys, 400° F.

FPP (2b)

Indium-Plated Parts

"Indium and Indium Plating." M. T. Ludwick (Indium Corp. of America) *Metal Finishing*, Vol. 40, Jan. 1942, pp. 13-17. Descriptive.

Indium is one of the rarer metals for which important new uses are being found. Pure indium is silvery white, softer than lead, malleable and ductile.

Indium is used industrially in bearings for internal combustion engines in aviation, automotive, and diesel fields. It protects bearing surfaces from corrosion from acids in lubricating oils. It confers desirable properties on dental alloys and is used in spectacle frame hinges to prevent corrosion.

At present, some of the most promising applications appear to lie in the plating field. In plating ferrous metals, some non-ferrous metal, which will alloy readily with indium, must first be applied to the base metal. Combinations of indium with copper, cadmium, zinc, silver, or gold are used today. Undercoating thickness varies with the use. On a bearing surface it may be 0.001 in., on decorative coatings a few ten-thousandths of an inch.

After plating, the indium coating must be diffused into the undercoat. Diffusion must be started below the melting point of indium (311° F.), but after diffusion is started the temperature may be raised to about 350° F. This treatment is usually given in an oil bath.

The finishes so produced have beautiful color and luster, and polish easily. Due to the fact that diffusion takes place horizontally as well as vertically, a non-porous coating with good corrosion resistance is produced.

Indium coatings show promise as reflector coatings. The reflectivity of indium is lower than that of clean silver, but it is believed that indium reflectors will maintain a high reflectivity, whereas that for silver drops off with time.

Experimental work is in progress on the use of indium in pharmaceuticals, and as a mordant for dyestuffs. It has recently been discovered that brazing materials alloyed with indium have excellent "wetting" properties.

Detailed directions are given for preparing and maintaining an indium plating bath. The bath has the following composition: indium (as chloride), 4 troy oz./gal.; dextrose, 2 oz./gal.; sodium cyanide, 12 oz./gal. Insoluble anodes, such as carbon or platinum, are used. The current density range is 10-100 amps./ft.^{2} The throwing power is excellent, and soft, matt-gray deposits are obtained. Any shop which is equipped to plate silver or copper will have the apparatus necessary to go into indium-plating immediately.

VAL (2b)

AIRCRAFT OUTPUT

Zooms

DESPATCH FURNACES

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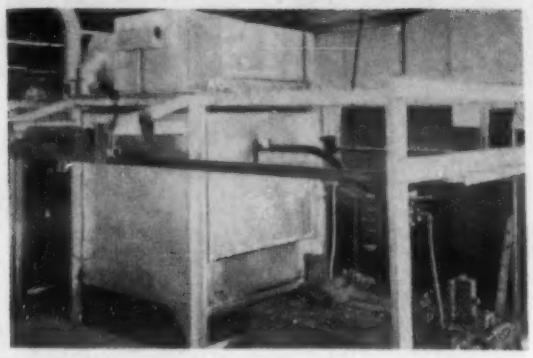

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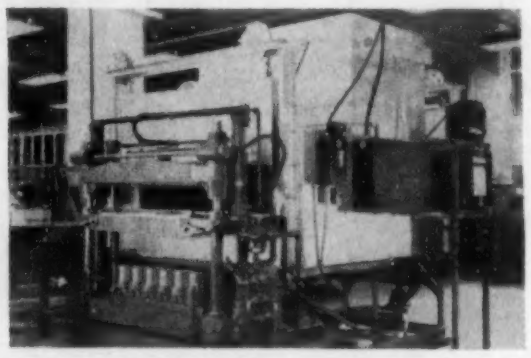
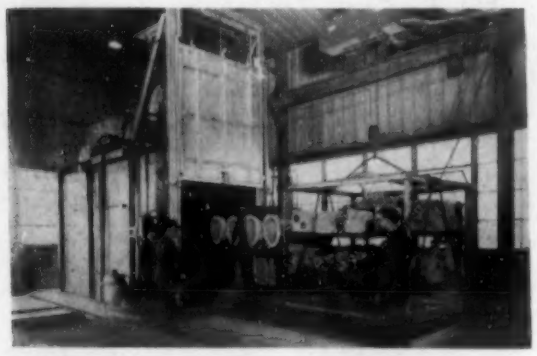


DESPATCH MONORAIL LOADED FURNACE in use at aircraft engine plant for pre-heating of motor assemblies prior to hot glycol test for leaks.



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Railway Tunnel Corrosion

"Some Corrosion Tests in a Railway Tunnel." S. C. Britton. *J. Inst. Civil Engrs.*, 1941, Vol. 16, Mar. 1941, pp. 65-72. Investigation.

Comprehensive tests were carried out in connection with the selection of materials of construction for equipment to be used in the removal of exhaust gases from steam locomotives. Both metallic and non-metallic materials protected by paints, by metal coats, or by thick wrappings are discussed.

The alloys exposed included mild steels, stainless steels (16% Cr iron and low-carbon 11/19% Ni/Cr steel, both exposed in the welded and unwelded conditions), stainless-clad steel, non-ferrous metals and alloys (copper, Everdur, aluminum-bronze, 80/20 cupro-nickel, aluminum), and cast iron (plain irons of 2 types and an austenitic iron containing 14.35% Ni, 6.2% Cu, and 2.03% Cr.

Mild steel corroded rapidly, and was not amenable to any notable chemical protection by paint, although an aluminum coating afforded temporary protection. Chromium steel pitted rapidly and the behavior of the austenitic steel was not much superior.

Copper alloys deteriorated far less rapidly than the ferrous materials. Everdur and cupro-nickel alloys were not so durable as copper, while aluminum sheet suffered severe local attack. Two specimens of aluminum bronze differed in behavior; one with a well-marked 2-phase microstructure was seriously embrittled, and the other, with only isolated fragments of a second phase, behaved like the other copper alloys.

Plain cast iron corroded as rapidly as plain steel. The austenitic cast iron, however, proved to be the best of the uncoated materials. JWD (3)

Metals in Telegraph Equipment

"Metallurgical Problems in the Telegraph Industry." Frances H. Clark (Western Union Telegraph Co.) *Mining & Met.*, Vol. 23, Jan. 1942, pp. 18-20. Practical.

In the telegraph industry many types of ferrous and non-ferrous metals are used, and, therefore, the failures that occur are of various types.

Both corrosion and fatigue affect copper wire, so that its normal life in any locality is dependent on atmospheric conditions. The wire is subject to a great range of vibrations caused by the wind, trains and other vehicles. It has been estimated that about 95% of copper wire breaks are fatigue failures; the other 5% are due to necking-down at fracture.

High humidity and temperature have caused localized corrosion where the stresses set up have resulted in corrosion fatigue cracks. On rare occasions fatigue failures occur in the lead covering of cables, but this is in no way connected with corrosion. Long service under conditions of alternating stresses produces this condition.

Owing to wear and tear on the mechanisms used in telegraph transmission equipment, only high grade ferrous alloys are used. In some cases failures of steel parts have been blamed on too high a temperature during the heat treatment. A specific example of failure is that of severe wear on the carburized teeth of a thin flat guide disk, attributable to uneven carburization.

In general, steels such as S.A.E. 3100, 4600, 6100 and oil hardening manganese steels have provided excellent service. Prac-

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But you did help build them. For the very same Republic Enduro* Stainless Steel that you might have been using today to resist corrosion and oxidation or to enhance sales appeal in civilian goods is now being used in the construction of naval craft—in practically all types of *Production for Victory.*

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It neither affects nor is affected by most chemicals and foods at high or low temperatures. And it can be fabricated without difficulty by ordinary equipment.

As the world's largest producer of alloy and stainless steels, Republic has acquired unequalled experience in the application of Enduro in almost every industry. And records established in these industries practically dictate the continued use of Enduro.

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tically all high speed equipment is provided with "oilless" type of bearings.

Some of the many failures observed on parts in high speed service are: (1) A cam of S.A.E. 1095 steel, which failed by a fatigue crack around the periphery—caused by insufficient annealing after blanking; (2) a clutch that failed through fatigue, the trouble being subsequently eliminated by placing a fillet at the base of the tooth (several alloy steels used for this part wore out), but all carburized S.A.E. 4615 steels resulted in satisfactory wear resistance.

Other interesting problems included: (3) a motor cut-off trunion that failed owing to a seam or slag streak rolled into the rod; and (4) a bad wear condition in the die and stripper plates of the punch-black assembly of a printer perforator, which was reduced by using an oil-hardening manganese steel. VSP (3)

3a. Ferrous

Nitrogen in 18-8 Stainless

"The Role of Nitrogen in 18-8 Stainless Steel." H. H. Uhlig (Gen. Elec. Co.) *Am. Soc. Metals*, Preprint No. 23, Oct. 1941 meeting, 34 pp. Research.

Very pure, nitrogen-free 18-8 alloy quenched from 2100° F. is actually ferritic, not austenitic, at room temperature. Nitrogen, which is accidentally present in the commercial (austenitic) alloy, is found to inhibit the gamma-to-alpha phase change occurring on cooling at about 210° F.

The alloys were prepared in pure alumina crucibles contained in a "vacuum-pour" furnace, from nitrogen-free iron, chromium and nickel. Melted in vacuum, the resulting ferritic 18-8's analyzed 0.001% N_2. Melted in nitrogen, the resulting austenitic 18-8's analyzed 0.165% and 0.24% N_2. The latter nitrogen content with carbon at 0.007% proved, within the limits of X-ray identification, to be sufficient to insure pure austenite phase.

The nitrogen-free alloy is ferromagnetic. The yield strength of ferritic 18-8 is 2.5 times that of austenitic 18-8 and the Brinell hardness 1.7 times. The conductivities, both electrical and thermal, are less, being about 70% that of the austenitic alloy. The coefficient of expansion below 930° F. is approximately 60% that of the austenitic 18-8.

The specific heat and density are about 2% less for ferritic 18-8. The tensile strengths are comparable, which is expected because austenite on deformation is converted to ferrite. The corrosion resistance of the two structures is the same for the long time heat-treated and water-quenched alloys. (3a)

Protection of Underwater Pipe

Experiences with Underwater Pipe Lines and Construction of an Underwater Gas Pipe with Novel Protection Against Corrosion ("Erfahrungen mit Dükerleitungen und Bau eines Gasdükers mit neuartigem Korrosionsschutz") H. Zimmermann. *Gas-u. Wasserfach*, Vol. 84, Apr. 12, 1941, pp. 225-231. Investigation.

Experiences with underwater (especially river crossings) pipe lines for gas and water are discussed. Protective coatings of several types proved to be unsatisfactory after long immersion; even very carefully laid-on jute and asphalt coating failed to prevent the water from ultimately penetrating to the steel pipe, which corroded and eventually leaked.

In one case, the final solution for the problem was found in the use of welded steel pipe protected with a sheath of lead, wood, asphaltum and jute. Even after several years no defect has developed.

The lead coating was produced in the following manner: Lead pipe of 0.20 in. wall thickness and of exactly the same inner diameter as the outside diameter of the steel pipe (6 in.) was carefully drawn over the latter, and the single lengths (16 ft.) of the lead pipe joined by soldering.

The joints of the steel pipe were then protected by 0.20 in. lead plates, which were hammered around the joint and soldered to the lead tube. Over the lead, wooden slats were bound with iron strip, and then the jute and asphaltum coating was applied.

Inside protection against corrosion is generally not required. In cases where condensate is formed (in gas pipes) because of temperature variations, it is best removed by blowing it out. Underwater pipe lines should, for reasons of safety, be in duplicate pipes so that in case of trouble the defective one can be repaired without interrupting the service.

Owing to the scarcity of lead in Germany at present, experiments were made to replace that metal with a synthetic rubber (Gomanin), which vulcanizes in air. The coating material so made was not attacked after 1½ yrs. exposure to each of the following: river water, distilled water, 0.1*N* HCl, 10% soda solution, 4% common salt

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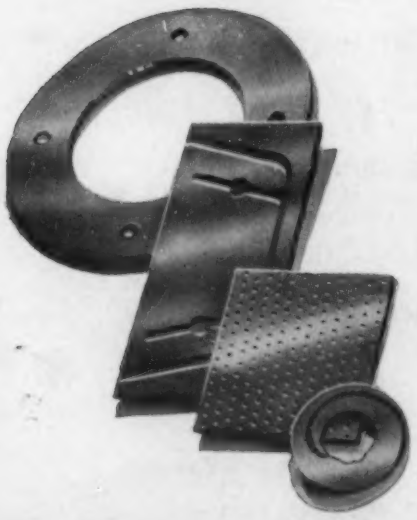
Pre-Cast Bearing BRONZE ON STEEL was originally developed for thin wall, sleeve type bearings and bushings. The bearing qualities of bronze and the strength of steel enabled manufacturers to increase speeds and loads . . . to gain longer life and smoother operation . . . greater resistance to shock and to wear.

Manufacturers are now finding many additional applications for *Pre-Cast Bearing* BRONZE ON STEEL. It is an ideal metal for washers, stampings or other flat pieces such as guide strips on presses and shapers, door slides, brakes, etc. For such applications, we can furnish BRONZE ON STEEL in rolls up to 400 feet in length or as flat strips either plain or graphited. The maximum width is 5½ inches with their thickness, 1/32", 1/16", 3/32". BRONZE ON STEEL is an ideal substitute for rolled bronze. Write today for the complete story on BRONZE ON STEEL. It's FREE.



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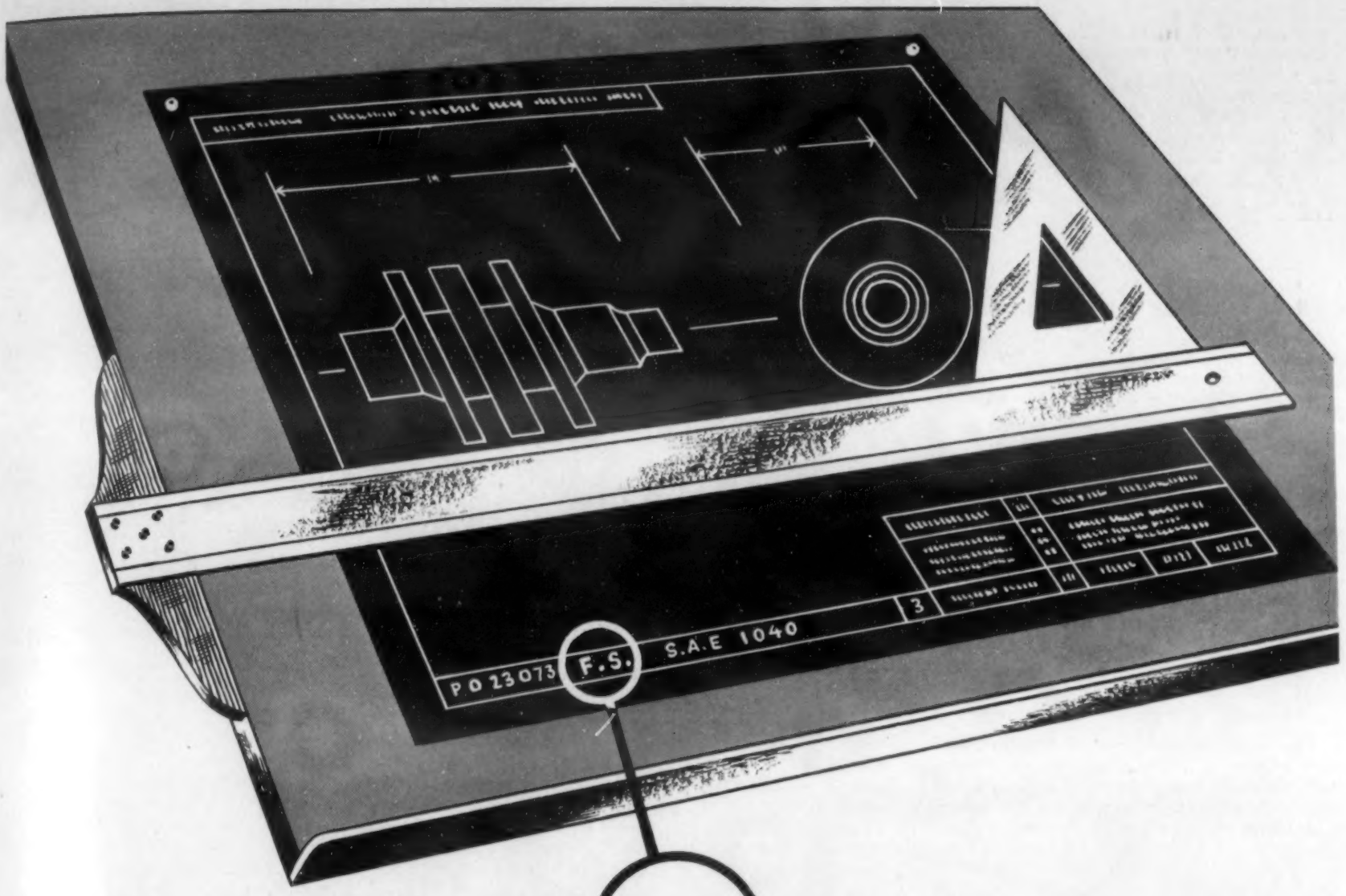


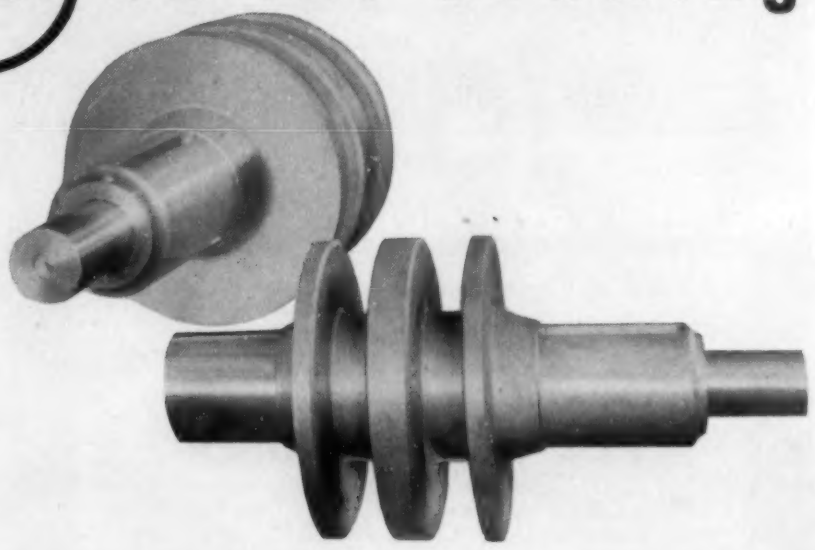
When You Write F.S. on the Drawing

When you finish up the drawing, write in the piece number and add F.S. SAE 1040, the "F.S." isn't just an afterthought. You've spent a lot of time on design, checked stresses and bearing values and worked out a number of associated parts.

You have a right to expect that the manufacture of the steel for the forging will be carefully controlled, and that the processes of forging and heat treatment of the piece will be in the hands of well trained experienced men.

Standard Steel has the equipment and the personnel to assure careful control from open hearth to finished forging.

Are you getting full value in *your* forgings? Specify Standard and be sure of it.



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solution, 0.1*N* H_2SO_4, 0.1*N* KOH, and a solution of 30% acetic acid and 5% sodium chloride in water.

A solution of 0.1*N* HNO_3 showed slight attack but only, as was found, on account of the aluminum powder filling that was used; with iron oxide as a filler, no attack took place.

This protection was used in the city of Lübeck on 3 pipes of 8 in. inside diameter laid 6 ft. below the river bed. After 2 yrs., no damage could be observed. MH (3a)

New Permalloy for Loading Coils

"Loading Coils with Cores of Molybdenum Permalloy." R. M. C. Greenidge (Bell Tel. Labs.) *Bell Lab. Rec.*, Vol. 20, Jan. 1942, pp. 119-122. Descriptive.

The former standard 81% Ni, 19% Fe permalloy is being superseded by an 81% Ni, 17% Fe, 2% Mo permalloy with the properties given in the Table.

Core Material	*Permeability*	*Loss Coefficient*		
		Hysteresis a x 10^6	*Residual* c x 10^6	*Eddy Current* e x 10^6
Molybdenum permalloy	125	1.6	30	19
Regular permalloy	75	5.5	37	51

The higher permeability of the molybdenum permalloy permits the size of loading coils to be decreased by 50%. Or, if coil size and inductance are kept the same, fewer turns of the higher-permeability modification can be used with a consequent reduction in d.c. resistance.

As shown above, the loss coefficients of the molybdenum permalloy are enough smaller than the standard permalloy to offset the effect of higher permeability and smaller volume. Conventional loading coil cases of welded steel and lead sheath types are used for the new small coils and units. JZB (3a)

The Graphitic Steels

"Graphitic Steels." Fred A. Bonte (Timken Roller Bearing Co.) *Steel*, Vol. 109, Nov. 24, 1941, pp. 80, 92, 96, 100; Dec. 1, 1941, pp. 96, 111-112. Survey.

"Graphitic" steels incorporate certain properties of steel and of cast iron. The basic composition, known as "Graph-Sil," contains about 1.5% total C, 0.40% max. Mn, about 0.03% max. each P and S, and 0.85-0.95% Si.

Graphitizing (done by normalizing from 1600° F., reheating to 1450° F., cooling in the furnace at about 40° F./hr. through critical range to 1100° F., and then removing from the furnace) gives a hardness of 170-190 Brinell, average of 0.99% combined C, and a structure that is highly responsive to heat treatment. After quenching into brine from 1500°-1550° F., the hardness is 64-67 Rockwell C. The structure is finely divided martensite with virtually microscopic linear inclusions of graphite uniformly dispersed.

To provide an oil-hardening steel, 0.25% Mo is added to the basic composition and silicon is reduced to 0.70-0.80%. This grade is known as "Graph-Mo." After quenching in oil from 1475°-1550° F., the hardness is over 66 Rockwell C. This grade is also easily machined, and is free from distortion.

To improve wear resistance, "Graph-Tung" was developed by adding 0.50% Mo and 2.60-3.00% W to the basic composition and reducing silicon to 0.60-0.70%. The hardness of this grade after brine or water quenching (heavy sections) is 69-70 Rockwell C, and from oil (light sections) 64-65 Rockwell C.

For parts subject to impact, a so-called shallow-hardening grade, designated "Graph-Al," was developed. About 0.20% Al is used as the graphitizer, with silicon being reduced to 0.15-0.25%. The combined carbon after graphitizing is about 1.25%. By heating to 1450°-1500° F. and quenching in brine, the case hardness is 68-69 Rockwell C, and the core 38-40 Rockwell C.

An air-hardening grade, called "Graph-M.N.S.," contains 1.25% Mn, 0.50 Mo, 1.75 Ni, 1.50 Si and 0.35 Cr. It is hardened by heating to 1650° F., air cooling, reheating to 1550° F., and air cooling. The hardness then is 63-64 Rockwell C. A large number of heats have been made by adding to the basic composition still other alloying elements, with interesting results.

All 5 grades are finding numerous applications as tools and dies. The use of prop-

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OFHC Copper conforms to the A.S.T.A. Specification for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact.

OFHC Copper withstands more working in hard condition when tensile strength is greatest, making it especially suited for products subjected to severe fabricating or service conditions.

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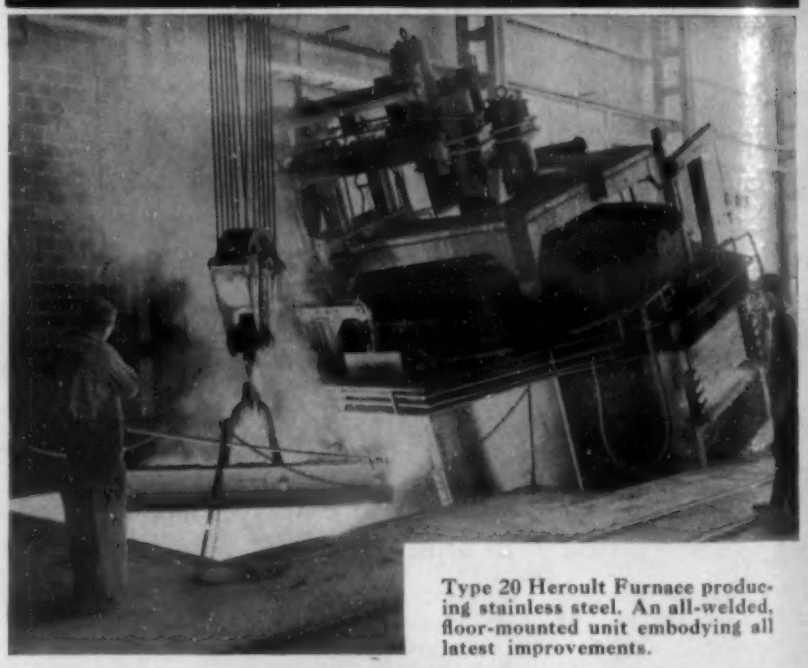

Type 20 Heroult Furnace producing stainless steel. An all-welded, floor-mounted unit embodying all latest improvements.

PARTICULARLY designed and equipped for high-quality melting and refining of ferrous materials by either basic or acid process—including alloy, tool and forging steels, iron and steel castings. Any capacity from ½ ton to 100 tons; removable roof, chute, machine or hand charging.

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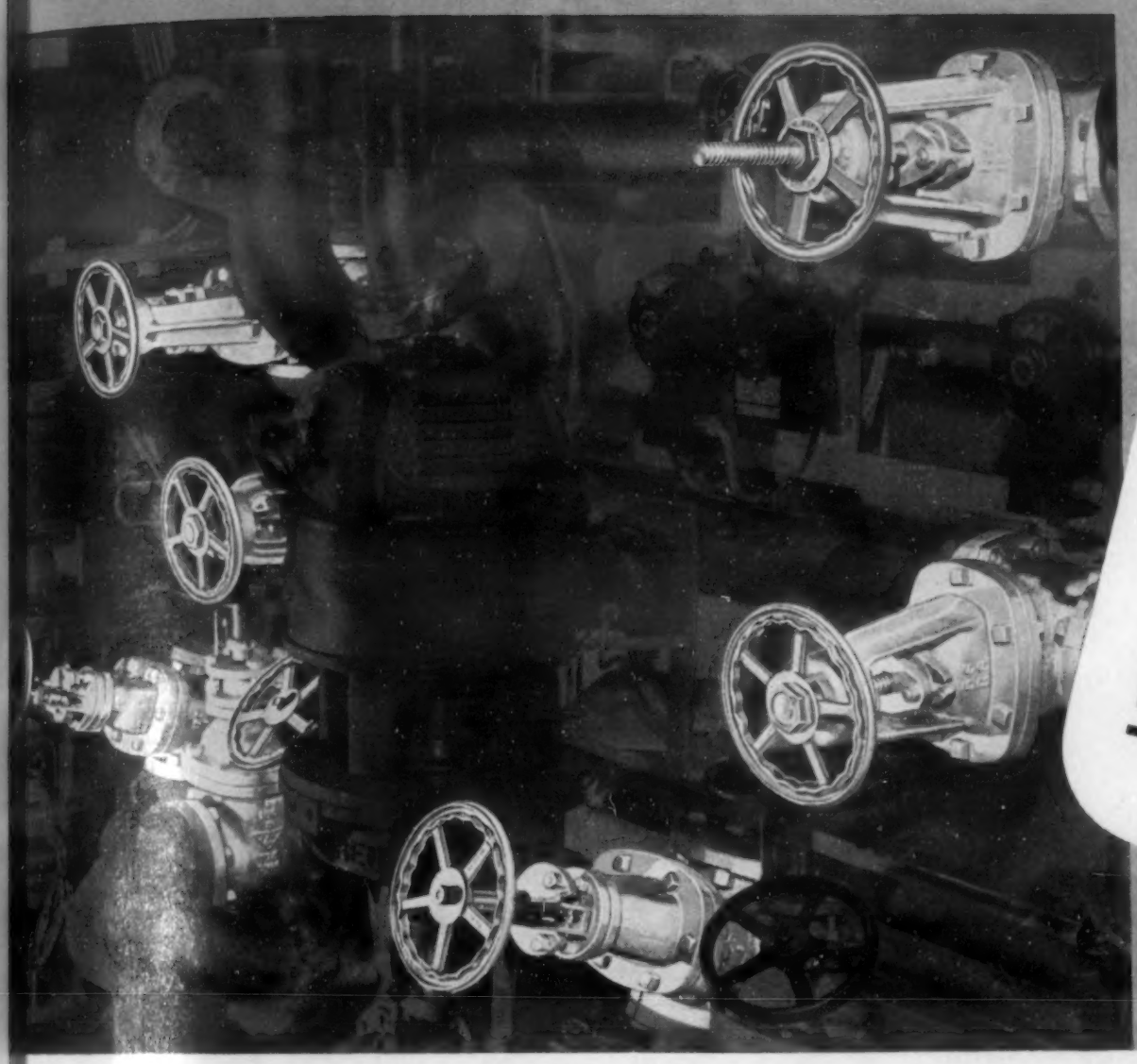

STEEL CASTINGS ARE DEPENDABLE

"The ships must get there" is the watchword, in these critical days, for both the Navy and the Merchant Marine. There is no time for breakdowns—for delays that may mean lives.

That's why marine engineers specify so many thousands of Cast Steel valves, for vital points where utter dependability is requirement number one.

Other industries — makers of almost everything mechanical—are in the habit of depending upon steel castings for service under extreme conditions.

Consider these important advantages of Steel Castings for *your product*. They stand up under high pressures and temperatures. They resist fatigue. They are easy and quick to repair. They can be hardened to suit the requirements of the job. A very wide range of mechanical properties is available.

Steel Castings make possible many economies in finishing and assembly schedules. Weight can be distributed exactly as needed, with little or no excess metal to machine off.

The result of taking advantage of these features is invariably a better product, and often, a lower cost of production.

Why not discuss with your own foundryman ways in which Steel Castings can help in improving and modernizing your own products—whatever you make? You'll find him anxious to cooperate, without obligation of course. Or if you prefer, write to Steel Founders' Society, 920 Midland Building, Cleveland.

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STEEL CASTINGS

erly hardened graphitic dies and tools results in a product free from scuffing or scoring, larger number of pieces before repairs are necessary, and a more accurate product. Some sample applications are metal-spinning rolls of "Graph-Sil"; gages and blanking and forming punches of "Graph-Mo"; dies of "Graph-Tung" for cold drawing bars, tubes, and deep-drawn articles from strip or sheet; tube-drawing mandrels of "Graph-Al"; and Neuberth mandrels of "Graph-M.N.S." for cold forming tubing.

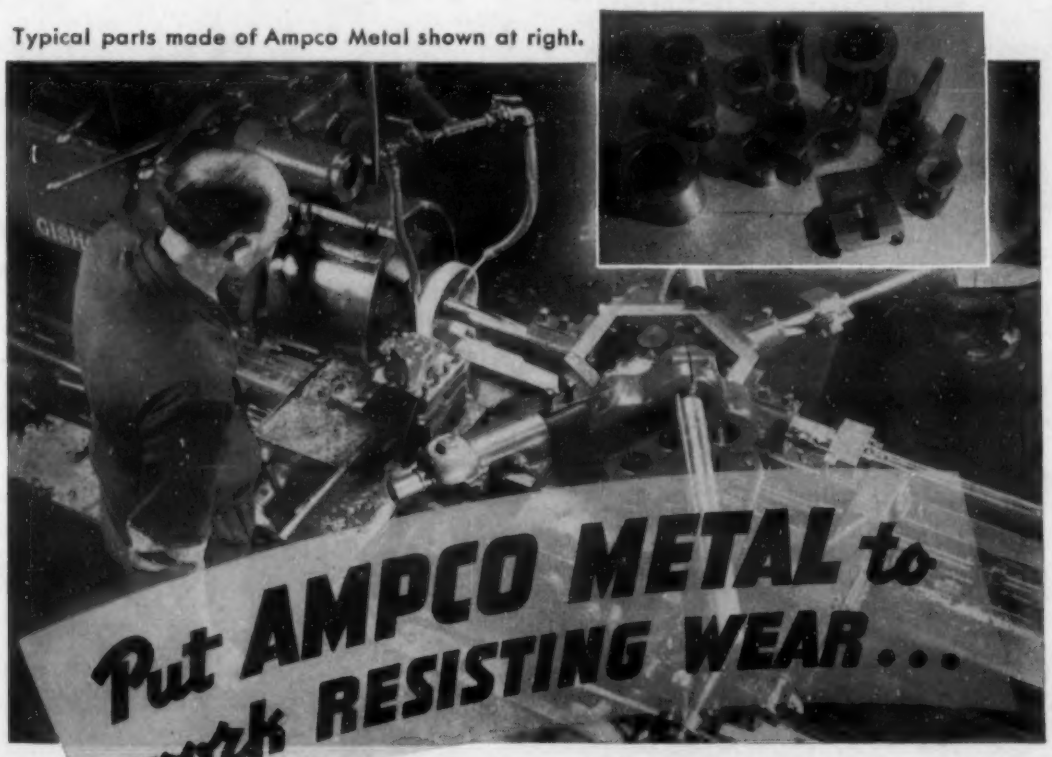
These steels are also being used successfully for oil seals, cylinder liners, air-hammer parts, Diesel pump parts, spindles, and other parts requiring freedom from scuffing or scoring, with adequate resistance to wear. MS (3a)

Alternate Materials in Military and Transport Vehicles

The need for substitution of less critical materials for those most strongly feeling the pinch is no less acute in the automotive industries just because they have virtually discontinued passenger car manufacture. On the contrary, any change in materials design that replaces a hard-to-get material with a satisfactory nd more available steel or alloy avoids raw-material delivery delay and speeds up the manufacture of the combat cars, reconnaissance buggies, "jeeps," trucks, tanks, aircraft engines and parts, which the motor vehicle industry is now producing.

On pages 403 and 404 of this issue, you will find two reference tables of alternates and substitutes for metals conventionally used in automotive product design—a comprehensive table covering several ferrous and non-ferrous alloys, plus a second table presenting certain possible alternates for engineering and machinery (S.A.E.) steels recently promulgated by the American Iron & Steel Institute. Even if you're not in the motor vehicle field, there are some obvious analogies in these tables for application to wartime engineering design in general. —The Editors

Typical parts made of Ampco Metal shown at right.



Longer service life of machine parts becomes imperative when a war production line may depend upon the smooth functioning of a machine tool. Today, many vital frictional parts have been redesigned to include Ampco Metal, an alloy of the aluminum bronze class, because of its marked wear-resistance.

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Actual installation tests prove that Ampco Metal has from five to fifteen times the life of ordinary bronzes. Today, as never before, such a metal appeals to production-conscious designing engineers as essential to continuous production. Many machine tool manufacturers have more than forty Ampco applications in their line of tools.

Not only machine tools, but aircraft, ordnance, heavy machinery, and other important war equipment include parts of Ampco bronzes. Ampco engineers are at your service. Ask for Catalog No. 22.

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Design Factors for Welded Joints

STRENGTH AND CALCULATIONS OF WELDED JOINTS ("Festigkeit und Berechnungen von Schweizzverbindungen") M. Ros. *Schw. Archiv. angew. Wiss. Tech.*, Vol. 7, Sept. 1941, pp. 245-271. Investigation.

Experiments were made with welded joints during the period 1936-1941 to determine suitable bases for engineering design of welded structures. A low-carbon structural steel was used with a tensile strength of 51,000-62,500 lbs./in.^{2} The electrodes used were high-grade coated electrodes with 0.07-0.10% C and 0.48% Mn. All tests were made downhand and overhead. A comparison was made between unmachined beads and beads machined flush with the parent metal. The results are as follows:

Butt Welds. In the tensile test machined and unmachined specimens broke outside the weld, and the tensile strength was greater by 10-15% than the original tensile strength of the parent metal. Fatigue tests (no-load to break-load) showed improvements of 20% due to machining in downhand welds and 30% in overhead welds. Annealing for 1½-2 hrs. at 1150° F. did not change the results.

Fatigue tests (½ load to full load) of butt welds gave results higher than the yield strength. The improvement in this fatigue value brought about by machining was 25% and 30% respectively for downhand and overhead welds; there was no improvement through annealing.

K-Welds (fillet welds with weld metal between the fillets too). Only fatigue tests (no-load to full-load) were made. Machining improved the results by 5% (tests perpendicular to the bead) and 10% (parallel to the bead). In all fatigue tests breaks usually occurred outside the weld when machined, and at the edge of the weld in the as-welded condition.

Fillet Welds. The tensile strengths of the fillet welds were lower than those of the parent metals. They are about 50,000 lbs./in.^{2} for flat welds, 50,000 lbs./in.^{2} for cross welds, and 40,000 lbs./in.^{2} for side welds. The fatigue strength values (no-load to full-load) were: Flat weld perpendicular, 10,000 lbs./in.^{2}; flat weld parallel, 28,000 lbs./in.^{2}; cross weld perpendicular, 10,000 for tension and 12,800 lbs./in.^{2} for compression cross weld, parallel 25,600 lbs./in.^{2}; and side weld parallel, only 12,800 lbs./in.^{2}

All results were identical for tension and compression except in the case of the perpendicular cross weld. Annealing and machining did not change the results. Several other unusual welds are described having fatigue strengths in the neighborhood of 28,400 lbs./in.^{2}

The theory of Mohr about the constant energy of deformation is cited and its ap-

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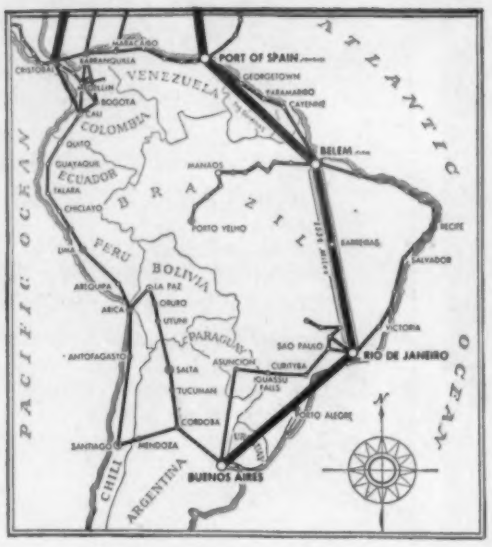

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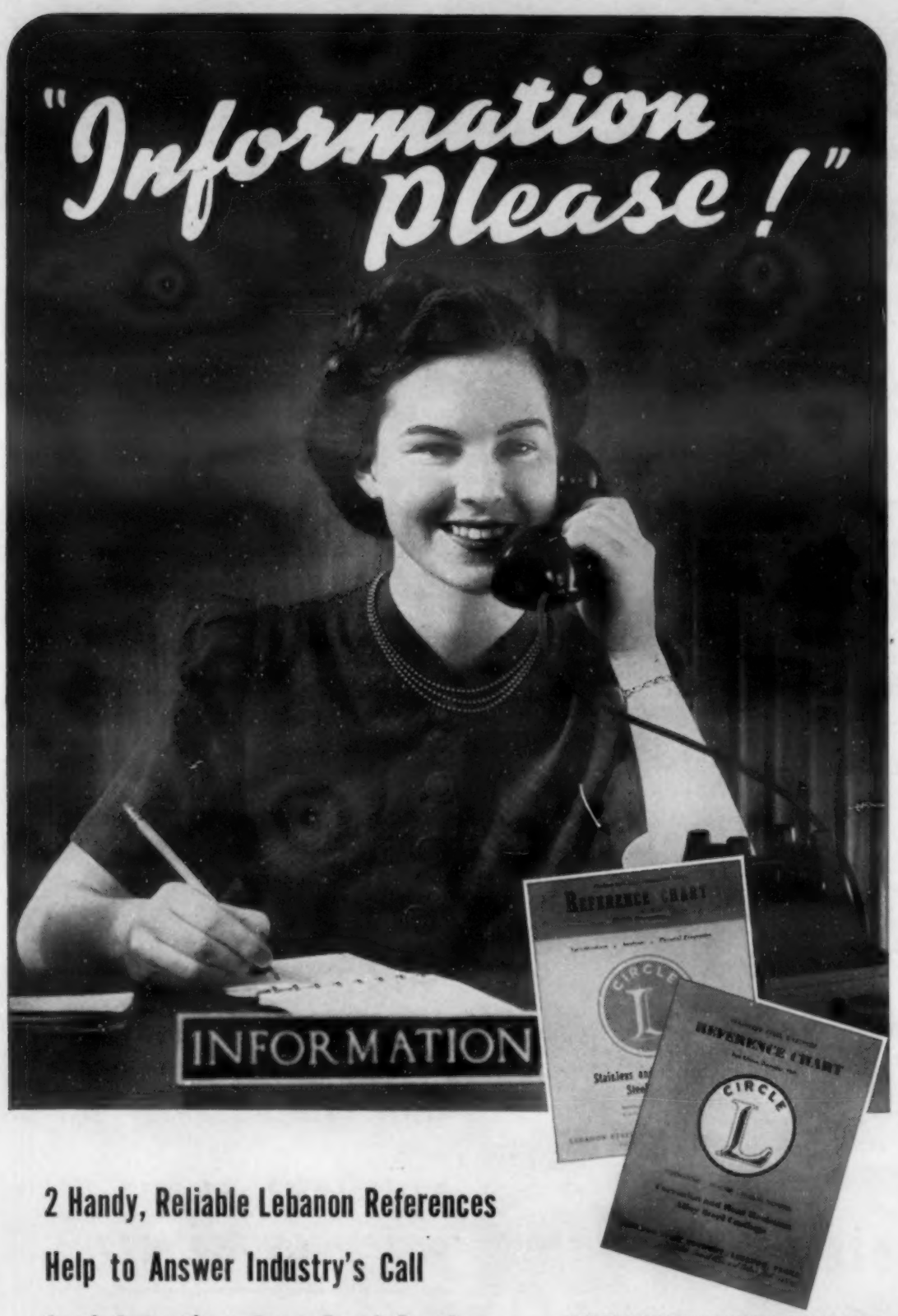

2 Handy, Reliable Lebanon References Help to Answer Industry's Call for Information about Steel Castings

MANY industries feel the need for clear, *concise* information about steel castings. As part of the Lebanon program to provide such data, two "thumbnail encyclopedias" have been developed. Both are easy to keep handy . . . easy to use. Both have a definite place in the reference files of any user of steel castings.

CARBON AND LOW STRUCTURAL ALLOYS REFERENCE CHART (*upper*) — Concise data on Lebanon Carbon and Low Structural Alloys. Specifications, analyses and physical properties are given. Also included are comparable classifications of U.S. Government, S.A.E. and A.S.T.M.

STAINLESS STEEL CASTINGS REFERENCE CHART (*lower*)—Covers Circle (L) Stainless, Corrosion Resistant and Heat Resistant Alloys . . . shows wrought and cast materials of comparable analyses. Designations, alloying elements, physical properties, heat treatment are covered.

Both charts are available to executives, engineers and metallurgists upon request.

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ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

CIRCLE L

LEBANON *Stainless and Special Alloy* STEEL CASTINGS

plicability in the case of these welds proven with isometric diagrams. Standards given for the examination of welders, include tensile strength, maximum hardness, bend tests, impact and fatigue tests of butt welds. Similar standards for all welded specimens to check the welding rods are given, and include in addition X-ray examination, and micro and macro structure.

Safe stresses have been increased the following amounts between 1930 and 1941: 40% for bridges and buildings, 25% for pipe lines, and 20-25% for boilers and pressure vessels. JMN (3a)

3b. Non-Ferrous

Magnetism of Iron-bearing Brass

"MAGNETIC STUDIES ON THE PRECIPITATION OF IRON IN ALPHA AND BETA BRASS." CYRIL S. SMITH (American Brass Co.) *Metals Tech.*, Vol. 8, Dec. 1941, 11 pp. Research.

Two series of brasses were prepared, one containing 30% Zn and the other 47% Zn. Each series contained varying amounts of iron. All were rolled to sheet and the remanence (residual magnetic moment) was determined after different heat treatments. Iron in excess of 0.03% could be precipitated from 70-30 brass by suitable low-temperature annealing. Precipitation was slow and occurred chiefly in a transitional non-magnetic form that was converted to a ferro-magnetic form by cold working.

The rate of precipitation in dilute alloys was greatly dependent on prior quenching temperature. Quenching from about 1475° F. produced the most rapid subsequent precipitation at 750°-930° F. Air cooling from 1475° F. or quenching from lower temperatures caused progressively slower precipitation even though the alloys were definitely homogeneous when quenched. This effect was not due to quenching strains and it was assumed to be associated with the location of the iron atoms in the lattice.

Beta brass containing 0.3% Fe or above was ferromagnetic when quenched from the solid-solution range, and actually became less magnetic during annealing at lower temperatures. Beta brass with less than 0.2% Fe was non-magnetic when quenched from the solid-solution range but readily precipitated iron at low temperatures in a directly magnetic form that was not affected by cold working. JLG (3b)

Light Metals in Cars and Trucks

"CONSTRUCTORS! HERE ARE SOME METHODS OF USING LIGHT ALLOYS IN VEHICLE CONSTRUCTION." R. F. TYLECOTE. *Sheet Metal Inds.*, Vol. 15, Dec. 1941, pp. 1537-1540; Vol. 16, Jan. 1942, pp. 69-71; 76. Review.

The advantages of light alloys in vehicles apply chiefly to the heavy transport class where the weight saving can be translated directly into increased pay load. There are certain design difficulties that must be overcome before light alloys can be used advantageously.

These difficulties have already been eliminated in modern heavy-vehicle construction, but are still factors in light car construction. However, a cheap French light car has done away with the conventional chassis and body construction, and uses only one unit of cast Silumin. German writers have recommended a mixed construction for light cars with main chassis members of steel and subsidiary chassis members and body work of light alloy.

Light alloys are generally used in ex-

Advertisement MARCH, 1942

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

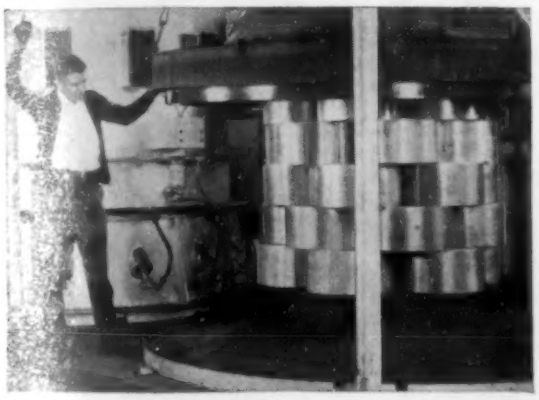
Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Standards for Copper Compiled by A.S.T.M.

A booklet entitled "A. S. T. M. Standards on Copper and Copper Alloys" has been published by the American Society for Testing Materials, which covers the various specifications and tests issued by the Society on copper and copper-base products.

Sponsored by Committee B-5 on copper and copper alloys, this compilation also includes specifications developed by Committee B-1 on copper and copper alloy wires for electrical conductors, together with selected specifications prepared by Committee B-2 on non-ferrous metals.

Copies of this 350-page booklet can be obtained by writing to the A. S. T. M. at 260 South Broad Street, Philadelphia, Pa.



Hard rolled copper comes out shining from this modern precision-controlled bright annealing furnace—part of the remarkably efficient brass mill equipment with which Bridgeport takes the initiative in setting new standards of quality. This furnace eliminates the unsightly coating of oxidation left when annealing is done with ordinary equipment, and assures Bridgeport customers "made-to-order" finishes which are often required for fabricating articles of a specialized nature.

Memos on Brass—No. 26

In these tremendously busy days when fabricators must quickly turn out many new types of work on their regular equipment, the adaptability of brass to different forming operations is especially valuable since it enables them to select the method best suited to their facilities. Brass, for example, can be subjected to severe cold working, heading, cupping, forming and spinning operations. And at the same time there is no sacrifice in quality as the composition and temper of brass can be regulated to give the best results for each process. The expert metallurgical assistance of Bridgeport's laboratory technicians is available without obligation.

Manufacture of Shell Bands is Relatively Easy for Fabricators

Tubing Supplied by Bridgeport Facilitates Finishing, Offers Simple Way of Changing Over to Defense Work

Fabricators who are contemplating turning all or part of their production over to defense work should consider the manufacture of rotating shell bands for projectiles, as the hard drawn tubing offered by Bridgeport Brass for this purpose may be finished easily and with a minimum of equipment.

The rotating band, a cylindrical ring generally made from commercial bronze (90% copper, 10% zinc) or copper tubing, is firmly attached to the projectile and is one of its principal parts. The ring is pressed into a circular groove which is located near the base or back end of the projectile. The base of the groove is roughened so that when the rotating band is hammered or swedged on it will not slip when the projectile is fired from the gun.

Other Defense Work

Fabricators desiring to change over to defense production will find further help in future "Copper Alloy Bulletin" articles which will discuss the materials supplied by Bridgeport for such parts as primers, fuses, time fuses and cartridge clips, together with the equipment necessary to finish them.

How Bands Function

The finished rotating band is made larger in diameter than the projectile. It affords a snug seat in the gun and centers the base of projectile in the bore, thus preventing the escape of gas forward between the projectile and the bore when firing takes place. The force of the explosion causes the band to engage in the grooves of the rifled bore of the gun and causes the projectile to rotate. This contributes to more accurate firing and longer range.

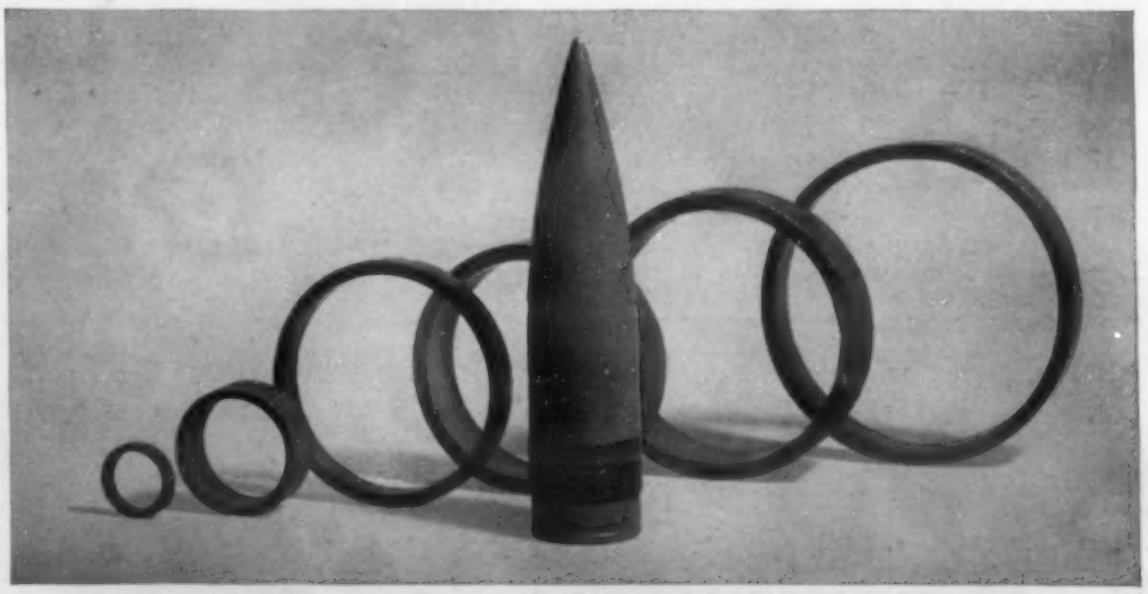
The hard drawn tubing supplied by Bridgeport for the manufacture of rotating bands facilitates sawing or machining and fulfills the chemical requirements of Government Specifications. The finished bands, of course, must also meet these standards. Navy orders for rotating bands carry complete information on their prints such as dimensions and composition.

Finishing Steps

Special machinery has been designed for cutting narrow rings off the tubing. However, automatic screw machines are used in some cases for small sizes with satisfactory results, although this equipment is not as efficient. Small establishments with low overhead who already have automatic screw machines can often compete successfully.

In most cases the rings or blanks are annealed in ordinary open fired muffle fur-

(*Continued on page 2, column 2*)



Tubing for the manufacture of projectile shell bands, such as those shown above, is but one of the many mill products made by Bridgeport Brass to help speed war production.

How Small Fabricators Can Obtain War Work

The series of articles on the properties and uses of the copper alloys usually published here is temporarily suspended because of the importance of the following material, which was abstracted from a booklet being prepared by the Copper & Brass Research Ass'n.

The fabricator seeking a Government contract or a subcontract should call on his nearest Regional Contract Distribution Office. He should take with him one of his engineers, together with photographs of the interior of plants or shops, and pictures or descriptions of products that are being made or have been made. The fabricator should be prepared to answer detailed questions in regard to his personnel set-up, equipment, power source, shipping facilities, and customers. When necessary, skilled production men will be sent by the Office for inspection and consultation with the management.

RFC Financing Available

The Reconstruction Finance Corporation will assist in financing fabricators handling war work through RFC loan agencies and through participation with banks. When necessary, loans will be made for plant equipment and for working capital to buy and process materials. An assignment will be taken as collateral, or part collateral, for such loans when possible.

Pools Can Be Formed

Many small plants that are unable to qualify for a prime contract are forming pools so that collectively they can handle work they could not do individually. An interesting example is the Manufacturers Defense Association, Inc., 122 W. 42nd Street, New York, N. Y. The Association is assisting in the formation of many chapters in other cities and will gladly answer inquiries from manufacturers or Chamber of Commerce organizations without obligation. Men cannot be loaned to chapters or other pools.

Another aid to the small fabricator is the subcontracting exhibits being established in key cities for the display of currently needed equipment and parts. In these exhibits, government purchasing agencies and concerns who hold defense contracts break down this equipment into subassemblies. Information about the location of such exhibits can be secured from any Regional Contract Distribution Office.

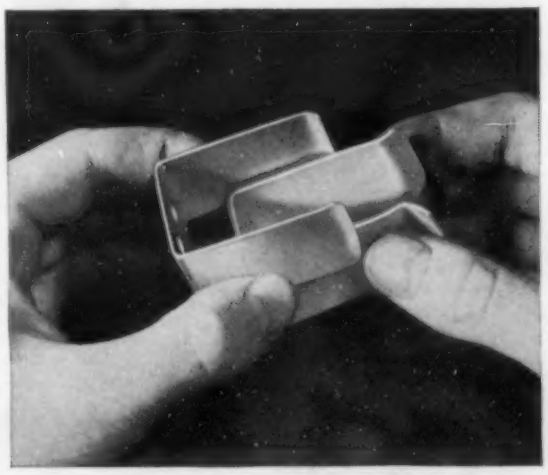
Making Shell Bands

(Continued from page 1, column 3)

naces, then pickled, washed and dried. When bright annealing furnace equipment is used, the pickling and washing steps are eliminated. The soft or annealed blanks free from burrs are packed and shipped to the arsenal or the projectile manufacturer.

The shell band is slightly larger than the diameter of the projectile and is slipped over it. Sizes 6 inches and smaller are swedged into the projectile groove by cold hammering with special equipment. Bands larger than 6 inches are heated to redness and are forced into the groove by hot hammering or hot swedging. When cooled off, the outside surface of the blank is machined and grooved to conform to standard practice.

Manufacturers who are anxious to make rotating bands are welcome to call on Bridgeport's technical staff for any services which we can render.



Lasting resiliency, durability, high resistance to corrosion and fatigue failure—these are some of the qualities that can be obtained in copper alloys. The outer contact clip (shown above), which is used in a drop-out fuse cutout, was made from phosphor bronze because it provided the exceptional springiness needed to keep the softer inner clip in shape after being forced apart repeatedly.

Brass Parts Used In Generator Chargers

In the wind-driven generator charging units specially designed and built for aircraft use by Champion Aviation Co., all electrical parts are made of cadmium-plated brass. Generators are equipped with voltage control and release to prevent over-charging and the propeller position can be adjusted on the four largest models to carry maximum power for all variations of cruising speed.

NEW DEVELOPMENTS

Plating tank nets for recovering dropped work have been developed which, it is claimed, can be used in cyanide copper, nickel, Mazic zinc, acid zinc and cadmium solution. They are not suitable for alkaline cleaners or sodium stannate tin solutions. The nets are made of ½-inch stretched mesh, hung square, six-thread medium twine to dimensions as specified. Tape is sewn in the form of loops along the top and bottom of both ends and sides large enough to accommodate a rod up to 1½ inches in diameter. **(No. 300)**

A blue filter glass compounded to eliminate injurious rays of light in conditions of excessive glare has been designed and is specifically recommended for aluminum and bronze welding, glass work, instrument making, and other operations where a sodium yellow glare is encountered. **(No. 301)**

A three-jaw universal chuck suitable for either lathe or screw machine work has been introduced. The body is semi-steel casting with jaws hardened and ground. A set of reversible jaws is also furnished. The chuck comes in four sizes—6, 7½, 9 and 10½ inches. A T-hand wrench is included with each chuck. **(No. 302)**

A tube fitting for steel, brass and copper tubing has been introduced which is available for tube sizes from ⅛ to 1½ inches. Each tube is held by compression set up by a ring when a holding nut is tightened. Threading or flaring is not required. Each fitting, it is said, will take not only its rated size of tube, but also any smaller size by applications of adapters and adapter nuts. **(No. 303)**

A polishing lathe has been produced which is said to reduce the amount of time required for chucking and eliminate wear on the machine because work can be fed into the hand-operated collet while the machine is operating. The spindle is ball bearing mounted. The range of speeds is 1250 to 5000 r.p.m. in infinite variation. The unit is powered with either single or three-phase ½-horsepower motor. **(No. 304)**

A master gage has been put on the market which is said to position thread cutting tools at the proper angle while being ground on any type of surface grinder. It consists of a one-piece hardened steel base, milled and slotted to position, and holds thread cutting tools at the proper angles on the grinding surface for standard thread cutting operations. The tool bit is held down tightly within the slot by means of two knurled head screws. A set screw takes up any lateral motion. **(No. 305)**

A cleaning machine has been developed for degreasing small parts in production and for application in tool rooms, laboratories and maintenance departments. It has a working depth of 14 inches, diameter of 14 inches, and stands two feet in height. Capacity operation is to two 15-pound loads per hour. **(No. 306)**

This column lists items manufactured or developed by many different sources. Further information on any of them may be obtained by writing Bridgeport Brass Company, which will gladly refer readers to the manufacturer or other source.

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FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

BRIDGEPORT BRASS

truded sections and sheet (plain and corrugated). Sheet to date has been either aluminum-magnesium alloy with 3 or 5% Mg, duralumin or magnesium alloy. Aluminum-magnesium alloy is preferred in England chiefly because of its easy forming properties. Magnesium alloy is chosen in Germany not only because it is a home-produced material, but also because of its unusually good weldability. Duralumin is unpopular because of the difficulties of working it, and the possibilities of corrosion.

High strength is required for structural members, but is unnecessary for stressed-skin construction, since here the greater thickness of light alloy needed for stiffness equal to steel provides the required strength (for example, to have resistance to bending equal to 0.032 in. steel sheet, aluminum must be 0.047 in. (50% weight saving), and magnesium 0.055 in. (60% weight saving).

Under 50% alternating impact stress, extruded magnesium alloy will result in a 25% weight saving over welded steel, but a magnesium alloy casting will have no weight advantage. Small pressings of light metals form extraordinarily strong and cheap joining sections, which can be easily formed in simple wooden drawing dies.

Workability is important not only in the construction of the vehicle but also in the case of slight damage in use. The aluminum alloy containing 3% Mg is easily worked, but its strength is impaired if it must be removed with a blow torch for repairs. Magnesium alloy is said to require less time for hand worked parts than aluminum or steel.

Light alloys are more easily riveted than steel. Soft iron or light metal rivets are used. "Explosive" rivets have proven useful.

Although welding has been little used for such work, it offers promise from the standpoint of weight saving. Magnesium alloy has the best weldability, then the 3% Mg aluminum alloy, aluminum, magnesium-manganese, and finally the 5% Mg aluminum alloy and duralumin. Magnesium alloy and duralumin both undergo loss of strength in welding. Welding should preferably be done with coated rods of the same composition as the sheet and all flux must be removed afterwards to prevent corrosion.

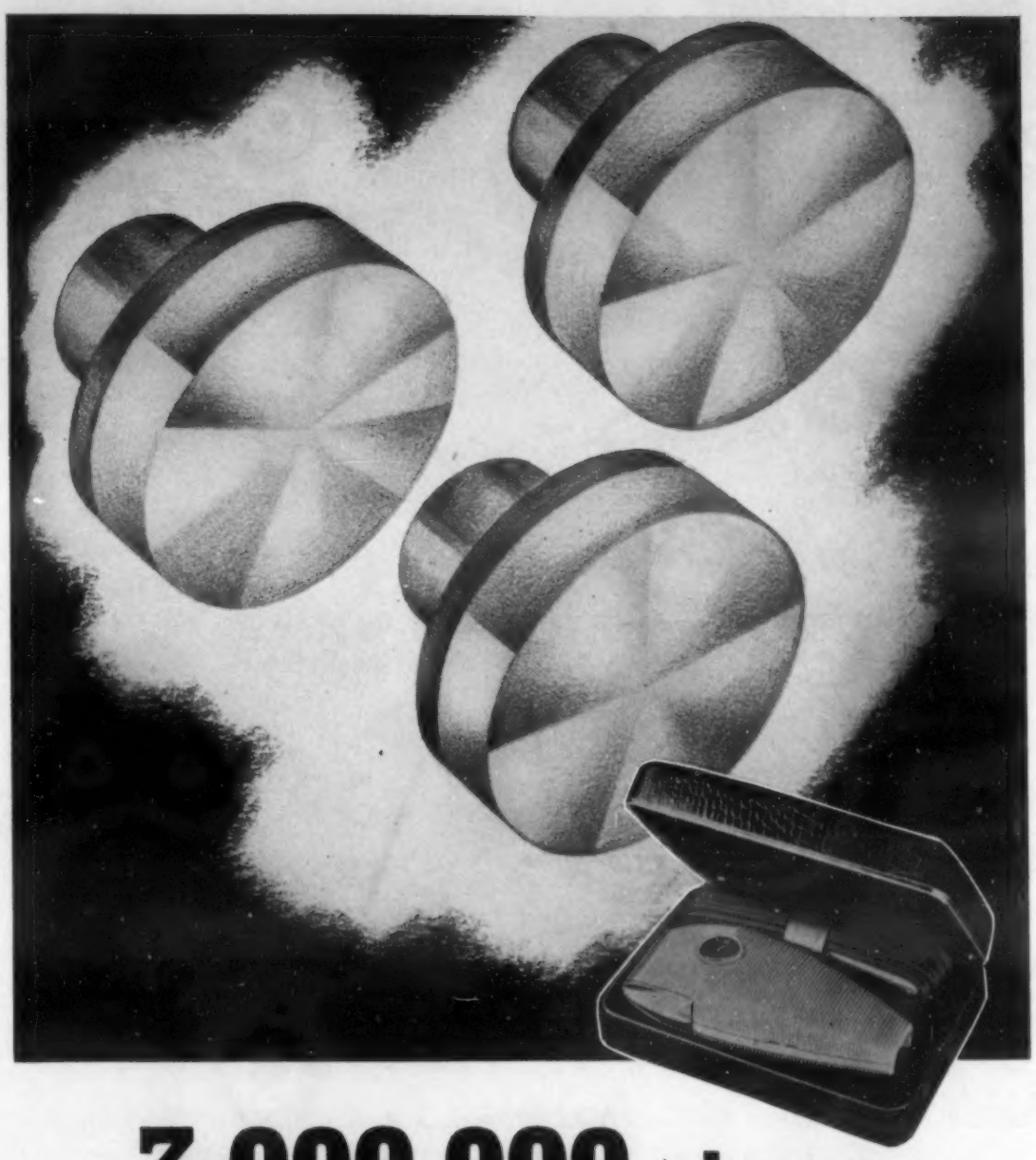
Corrosion may be of three types: contact corrosion, condensation and atmospheric corrosion. In the case of iron rivets, the holes should be painted beforehand with bitumastic suitably pigmented to prevent contact corrosion. All joints should be coated with paint before assembly.

Galvanizing or cadmium plating can be used for bolts and other steel parts, while metal spraying can be used to insulate fixed parts against contact corrosion. If the joints will move in use, insulation materials in the form of elastic bands or strong paper should be interposed.

Condensation corrosion on the inside of body panels or between double panels will be hindered by occasional repainting. Atmospheric corrosion will affect only the duralumin, as the other light alloys used have good corrosion resistance even when unpainted, with the possible exception of magnesium in salt air.

Light alloys seem to stand up better in accidents, since the energy required for a given amount of deformation is proportional to the volume of the metal, which for an aluminum alloy is about 4 times that of steel, and for a magnesium alloy, about 10 times. Complete light alloy vehicles are foreseen as a post-war development.

JZB (3b)



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4 Testing and Control METHODS, EQUIPMENT

Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • X-ray and Magnetic Inspection • Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings, Surface Measurements • Metallographic Structure and Constitution

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Using Radiography in Industry

"THE APPLICATION OF X-RAYS TO INDUSTRIAL PROBLEMS." W. BETTERIDGE. *Engineering Inspection*, Vol. 6, Autumn, 1941, pp. 5-15. Review.

A few elementary facts about X-rays may be worth reviewing before discussing some modern applications of radiography. X-rays are generated when rapidly moving electrons are suddenly stopped by impact with solid matter. In order to obtain electrons moving sufficiently rapidly, they have to be generated in an evacuated tube, usually by a hot filament emitting thermionic electrons. These are accelerated by a high potential usually between 20 kv. and 400 kv., although voltages both above and below these limits are used.

The electrons are focussed to fall on a relatively small area of the solid body, which consists of a high melting point metal (tungsten). It is this area that forms the source of the X-rays, which are radiated from it in all directions.

The character of the X-rays emitted under these circumstances depends on 2 or 3 factors. The total intensity of the rays increases very rapidly with increasing voltage, but more important from the radiographic point of view is the fact that the wavelength of the rays of maximum intensity falls with increasing voltage. The penetrating power of X-rays increases as the wavelength gets shorter; thus, as the voltage applied to an X-ray tube is raised, the rays generated become more penetrating as well as of greater intensity.

Moreover, if the applied voltage is high enough, high-intensity X-rays of a very sharply defined wavelength are also emitted, and are super-imposed on the general or "white" radiation. The monochromatic rays are called the "characteristic" rays, since the wavelength is characteristic of the material of the target of the X-ray tube. The wavelength of the characteristic rays falls steadily as the atomic number of the target material increases. These rays are of little importance in radiography, but are one of the essential factors in X-ray diffraction.

Procedure Factors with X-rays

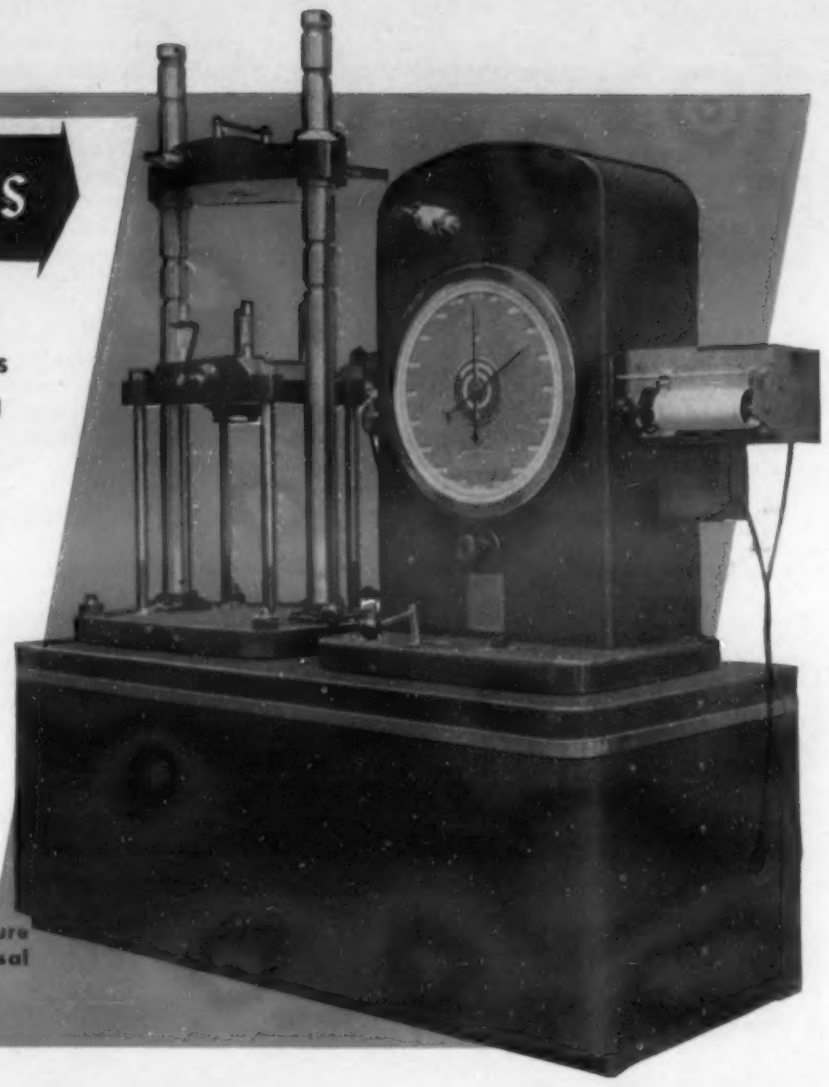
The property of X-rays that makes them so useful in the radiographic field is their ability to penetrate all matter to a greater or less degree. The absorption coefficient of a material increases with increasing density of the material. Similarly, the absorption coefficient of the material falls as the wavelength of the X-rays falls, but there are discontinuities at certain wavelengths called the absorption edges, which are associated with the characteristic rays of the material in question.

In radiographic inspection the X-ray tube is placed above the part and rays diverge from the focal spot of the target in all directions; on passing through the material being tested, the rays suffer a reduction in intensity before falling on the fluorescent screen or photographic film, which is placed beneath the body. If, however, there is a hole in the middle of the body, the rays will be less absorbed in passing through it, and consequently will emerge with a greater intensity behind the hole than elsewhere.

The screen or film serves to make these variations in intensity visible to the eye, the image obtained being in effect a shadow picture of the block and its interior. Similarly, if instead of a hole we have an inclusion of a denser material in the block, it will result in the X-rays' being of less intensity behind it and a corresponding shadow will be formed.

UNIVERSAL TESTING MACHINES

OLSEN



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MACHINES AND INSTRUMENTS DESIGNED AND BUILT TO MEET SPECIAL REQUIREMENTS

The choice of whether to use a fluorescent screen or a photographic film depends on the problem in hand. The fluorescent screen is by far the most convenient since the image is immediately visible, but it suffers from several disadvantages compared with the photographic film.

In the first place, it is much less sensitive since instantaneous response is required, whereas the film is cumulative—even the weakest image being detectable if a sufficiently long exposure is given. This means that a much greater thickness of material can be examined photographically than by fluoroscopy.

The fluorescent screen is also less sensitive to small variation in intensity, so that slight changes in absorption of a body are less easily detected, and it also has a relatively coarse grain so that the finer structure of a body cannot be revealed. The consequence is that it is only used when the limited sensitivity is no handicap, such as in the examination of castings for defects of a magnitude known to be detectable.

In the production of a satisfactory radiograph (photograph), the intensity of the X-ray source itself is, of course, of first importance, and this is directly proportional to the current passing through the tube. Similarly, the distance of the tube from the film controls the intensity of the image, the intensity following an inverse square law. These are the main factors controlling the intensity of the initial X-ray beam as it reaches the film, but the final intensity is, of course, much influenced by the absorption in the body being examined.

Finally, the exposure time necessary to produce a suitable density depends on the type of film used of which several are available, the use or non-use of intensifying screens and the method of development. The correct exposure is a matter of experiment and experience and is read from previously prepared charts.

The distance of the tube from the film determines to some extent the sharpness of the shadow picture, and therefore, the ratio between the distances tube-object and object-film. The focal area of the tube has a similar effect—very fine focus tubes are available with which it is possible to take radiographs of remarkable detail, but it is necessary to keep the tube current low on these to prevent overheating of the focal spot. Consequently, such tubes are not used unless the fine focus is particularly desired.

Then with any particular object to radiograph, it is necessary to decide what voltage to apply to the tube—whether to use the penetrating rays given by a high voltage or the softer rays, with the consequently longer exposure, given by a low voltage.

Frequently it is impossible or undesirable to record the whole range of thicknesses on a single radiograph, and it is then necessary to make 2 or more exposures; another difficulty now appears, since when the exposure is made to penetrate the thicker portions the thinner parts are grossly over-exposed and severe halation from these parts of the film tends to fog the correctly exposed image of the thick part.

The effect is particularly noticeable when the rays reach the film without passing through any part of the body, such as round the edge of a small body or through any holes. It can be overcome in several ways—directly by blocking off the gaps or thinner parts of the body, usually with sheet lead, but this is tedious if the body is of a complicated shape. A method sometimes used is to immerse the body in a liquid with a high absorption coefficient such as solutions of lead or barium salts.

Extremely useful material for blocking off is commercially available as opaque plastic consisting of a soft wax containing a high proportion of a dense powder such as lead oxide—this can be readily molded to the area to be blocked off and after use can be stripped off and used repeatedly. Fine shot lead is convenient in some cases, and a material often readily available in industrial plants is the steel shot used for shot blasting.

A good deal of improvement in the matter of halation can be effected by the use of filters of a few mms. of a heavy metal (usually copper). These can be placed in the X-ray beam as it emerges from the tube, or much better if a large sheet of uniform thickness is available, between the object and the film.

Scattered or secondary X-rays tend to fog the film and hide the detail of the image. They can be kept to a minimum by always ensuring that the area covered by the initial beam is only just sufficient to embrace the object or portion of an object which it is desired to examine, and for this purpose diaphragms of various sizes are used. Scattered rays can also be reduced in intensity to some extent by filters of heavier metals between the object and the film.

Intensifying screens are of 2 types, fluorescent salt screens and metal screens. The film is tightly clamped between two of these screens and the X-rays passing

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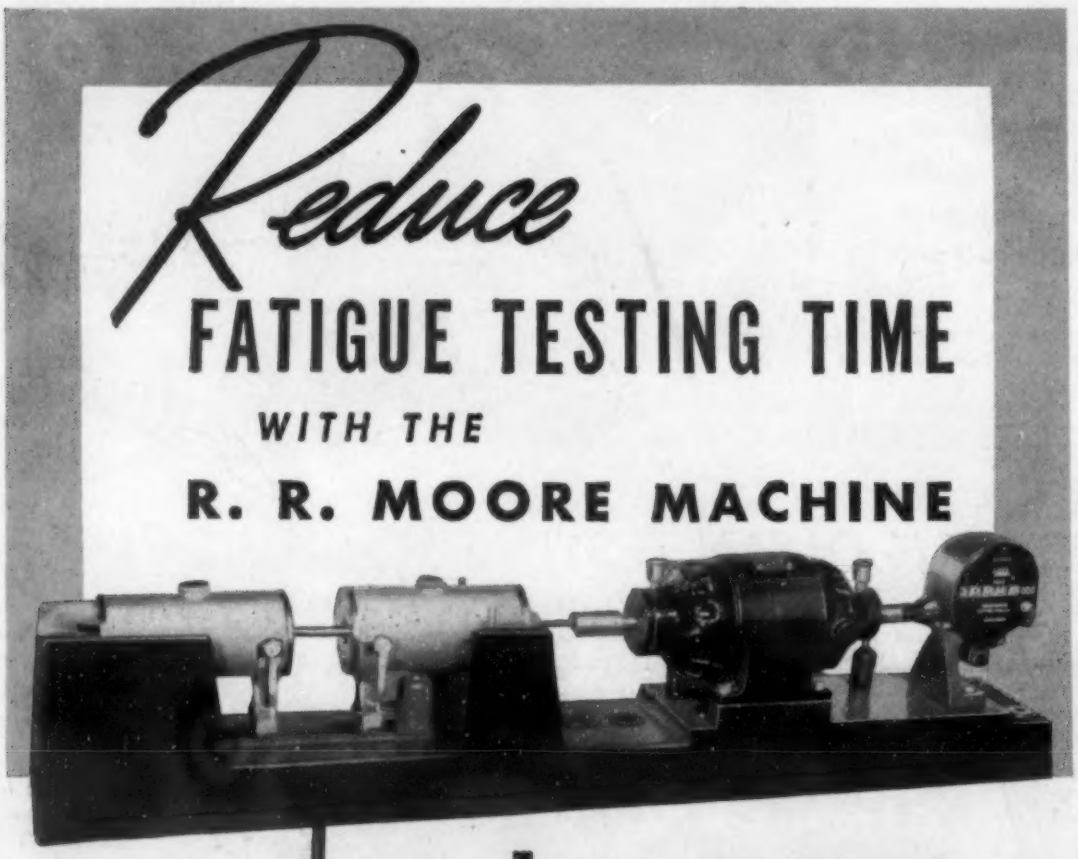

Improved to meet the demands for rapid fatigue tests, the R. R. Moore high speed Fatigue Testing Machine now operates at speeds of 10,000 rpm. The machine is equipped with a variable speed drive—an essential feature in the testing of certain alloys which heat up when highly stressed and it also allows correlation of high speed tests with previous lower speed tests.

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through the sandwich cause the salt screens to emit visible light which acts on the film and causes blackening in addition to that caused directly by the X-rays. The metal screens, usually about 0.003 in. thick and of lead, or tin, act in a similar manner but instead of visible light, they emit secondary X-rays and electrons.

Salt screens reduce the exposure time to something of the order of one-tenth or one-twentieth of the normal time, but they reduce the sharpness of the image on account of the grain size of the screens. Metal screens similarly slightly reduce the sharpness, although much less than the salt screens, and reduce the exposure to ½ or ¼ normal, and also have a very useful filtering effect.

Fields of Service

The two familiar purposes for which radiography is mainly used in industry are the examination of metal castings and of welds. The field next in importance is the examination of assembled structures to ascertain that all the parts are correctly fitted together. Such products as large radio tubes, electric heater elements, small ammunition, shell fuses, spark plugs, etc., are all examined in production quantities. Such work is very often satisfactorily carried out by fluoroscopic methods and conveyor belt viewing screens make the examination of large numbers of articles quite speedy.

A welded steel structure is shown in which a plug between the plates was welded in position, and after cleaning up the surface, the exact location of the plug could not be determined. Owing to the distortion of the plates, it was uncertain whether the hole then drilled was concentric with the plug.

A radiograph shows clearly that in all 4 plugs the hole is somewhat eccentric and by measuring the radiograph with a travelling microscope an accurate determination of the eccentricity was possible.

It is very often desirable to know the exact position of a defect in the interior of a body and a single radiograph locates it only with respect to 2 axes, but not with respect to the third, since the image of the solid body is projected on to a plane. The position of the defect can be located by taking a second radiograph at a different angle, but it is very often convenient to make 2 exposures on a single film, the position of the X-ray tube being moved between the exposures. By measuring the shift of the image and the shift of the tube, the distance of the defect from the film is given by simple geometry.

The thickness of a plate which is inaccessible to normal methods, such as boiler walls or ships' hulls, can be measured by this method by placing a small lead marker on the surface of the plate remote from the tube and treating the problem in an exactly similar manner. A better method, which does not involve movement of the X-ray tube and double exposure, is to place a lead strip in which an aperture of known size is cut on the face of the plate nearest to the tube. Then from the size of the image of the aperture on the radiograph and the distance of tube to film, the plate thickness is given by treatment of similar triangles.

A refined development of radiography which is proving of some value in metallurgical work is the so-called microradiography. Thin slips of metal are prepared—about 1/10 mm. is a usual thickness, although up to 1 mm. can be used. These are radiographed on very fine grain plates with low voltage X-rays.

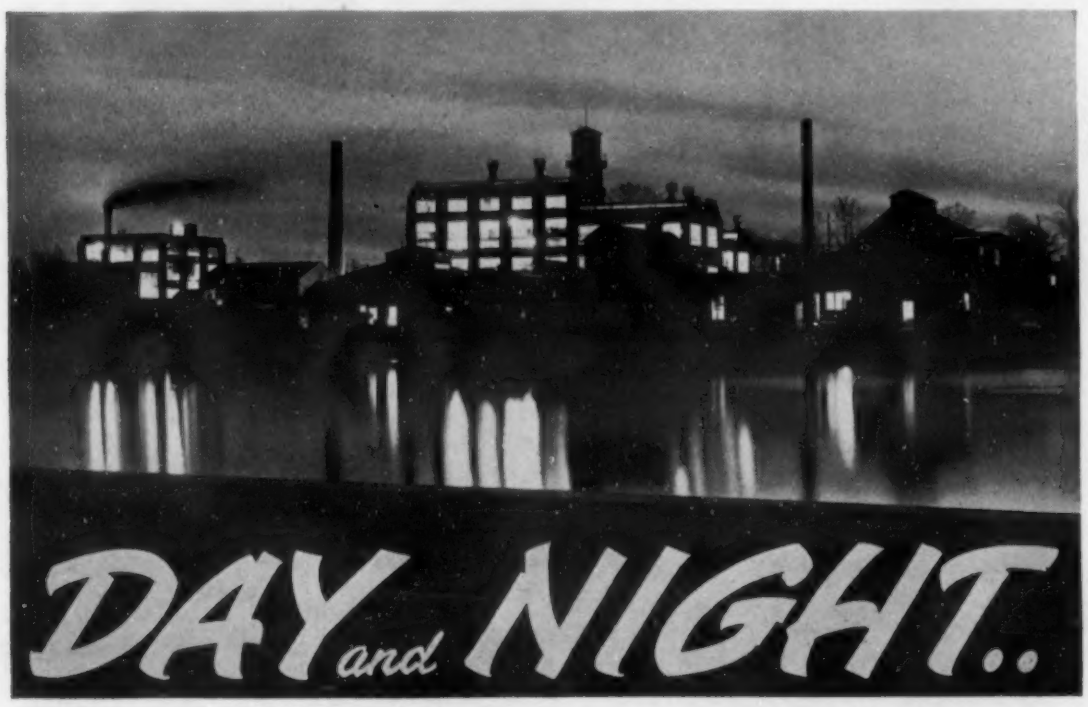
Subsequent optical enlargement gives the equivalent of a photomicrograph, revealing variations in composition by the consequent variation in absorption. The method is of most value in the study of coring and segregation in a solid solution.

Segregation of the component metals of an alloy is, however, often revealed in a normal radiograph if it is of a coarse enough grain. It is frequently seen in aluminum alloy castings due to the wide differences in absorption coefficient between aluminum and the alloying elements such as copper and nickel, and sometimes in cast steels if they are sufficiently alloyed. Copper-lead bearings are often radiographed as a routine examination since the lead and copper are discrete phases and their relative distribution is clearly shown.

Gamma-Ray Radiography

Gamma rays are emitted by certain radioactive elements and are shorter in wavelength than X-rays produced by even the highest voltage normally used, and hence are much more penetrating. In fact, the gamma-rays from radium will economically penetrate about 8 in. of steel against 4¼ in. by 400 k.v. X-rays.

The practice of taking a radiograph with gamma-rays is exactly analogous to that followed with X-rays, the source of the gamma-rays replacing the focal spot of the X-ray tube. Because radioactive materials need no attention, it is usual to set up the pieces for examination during the daytime in a ring around the position in which the gamma-ray source is to be placed and to ex-



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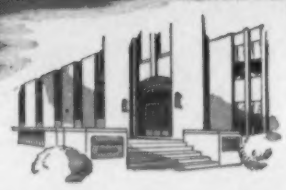

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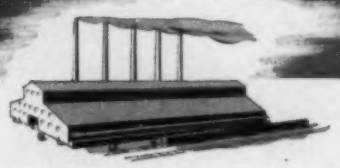

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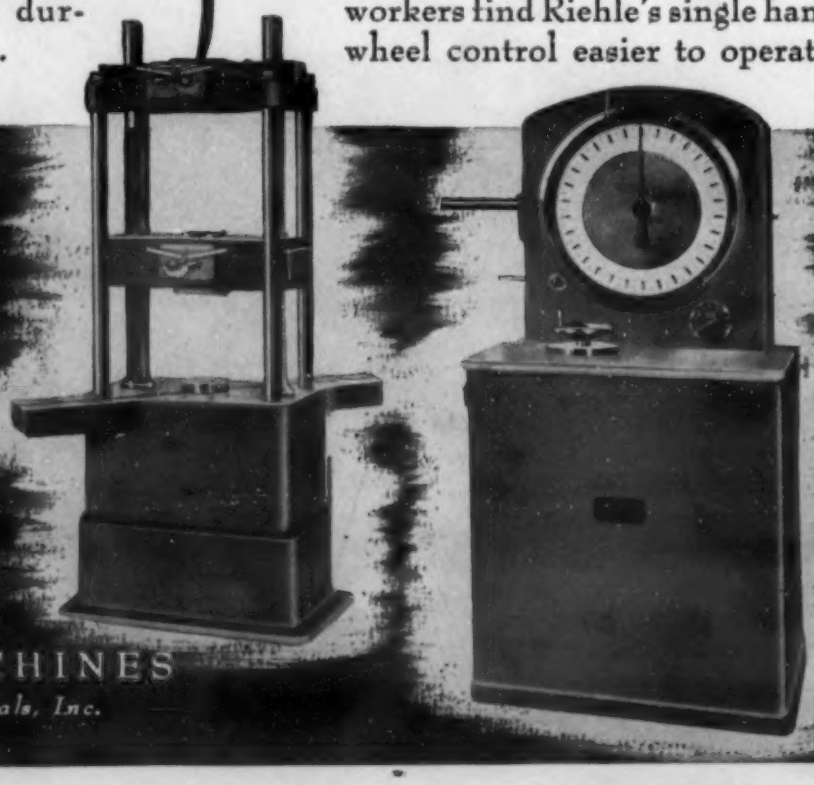

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pose overnight. The control of exposure for different thicknesses is made by varying the distance from source to film.

The interpretation of the gamma-ray radiographs needs no further explanation since they are exactly the same as X-ray radiographs—except perhaps to remark that the contrast obtained is considerably reduced; but this is to some extent outweighed by the fact that there is less obscuring of the image by scattered radiation

(4)

Hardenability Testing Standards

"SAE STANDARD PROCEDURE RECOMMENDED FOR TESTING HARDENABILITY OF STEEL." *S.A.E. Journal*, Vol. 50, Jan. 1942, pp. 15-20, 44. Recommended practice developed by the Subdivision on Hardenability Tests, Iron & Steel Division, Standards Committee, Society of Automotive Engineers.

Much of the material prescribed in the procedure was obtained from the S.A.E. symposium abstracted in METALS AND ALLOYS, Vol. 14, Nov., 1941, pp. 794, 796, 798. The new report recommends the Jominy End-Quench Test.

The preferred test specimen is 1 in. diam. by 4 in. long with 1¼ in. diam. by ⅛ in. thick flange at one end. Optional specimens may be 1 in. diam. by 3 in. long with tapped hole in a bolt screwed in, or 1 in. diam. by 4 in. long used with a screwed-on ring. For shallow-hardening steels, Jominy's Type-L specimen, the conical specimen of O. V. GREENE & C. B. POST [*see* METALS AND ALLOYS, Vol. 14, Nov., 1941, p. 796], or B. F. Shepherd's P.-F. specimen may be used.

For steel received in bars less than 1 in. in diam., the test-piece may be ¾, ½ or ¼ in. diam. and end-quenched as prescribed for 1 in. rounds. Modifications in water orifice are required for quenching smaller specimens. The test specimen shall be made from normalized steel. Hardenability tests made under any other conditions are subject to agreement between supplier and user.

The specimen shall be heated to the proper hardening temperature for the steel under test in 30-40 min. and held at that temperature for 20 min. The atmosphere must be such that virtually no scaling and little decarburization take place. If there is no properly controlled atmosphere, the specimen may be inserted in a suitable container and placed with the bottom end of the specimen resting on cast iron chips. The container should be covered to prevent circulation of furnace gases in it.

The time required for the specimen to come to temperature must be determined by a thermocouple to be sure that compliance is made with the heating time requirements. In quenching, the test-piece shall be placed on a fixture so that a column of water at 75° F. ± 5° F. may be directed against the bottom face of the piece. The column of water passing through a ½-in. diam. opening shall rise to a free height of 2½ in. above the opening. Fixture must be dry at the beginning of each test.

The water shall be shut off with a quick-opening valve, and the hot specimen placed over the water-pipe so that the bottom of the test-piece is ½ in. from the opening of the water pipe, and the water shall then be turned on. The sample shall remain on the fixture for at least 10 min. Still air shall be maintained around the piece during cooling.

For a ½-in. test-piece, the orifice size is ¼ in.; the distance from the orifice to the

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quenched end of the specimen is ⅜ in.; and the free height of the water column is 4 in. For a ¼-in. test bar, the orifice size is ⅛ in., distance from orifice to quenched end of sample, ¼ in., and free height of water column, 8 in.

Then 2 flats 180° apart shall be ground 0.015 in. deep along the entire length of the bar and Rockwell hardness measurements made along the center-line of these flats. Tempering must be avoided during grinding.

Hardness readings shall be taken in 1/16-in. steps. Readings at identical distances shall be averaged for plotting. When a flat is used as a base, previous indentations shall be ground away. It is advisable to use a fixture for holding the sample, which facilitates positioning it for each hardness test at 1/16-in. intervals. Resting the sample in a V-block is not permitted.

Tests should be plotted on a standard chart prepared for this purpose in which the ordinates represent hardness and the abscissae represent distance from quenched end, plotted with wide spacing per 1/16 in. at the quenched end and gradually decreasing to the other end. This type of plot provides a less steep curve for shallow-hardening steels and facilitates comparison of the one curve with another.

The spacing is derived from the scale of cooling rates appearing at the top of the chart. Expression of the abscissa also in terms of cooling rates permits direct comparisons between steels tested with the standard end-quench test-piece and those tested with other specimens. There are also charts for using a curve showing hardness and cooling rate, to predict hardness U-curves in various-size rounds when oil or water quenched, and for preparing a curve showing hardness and cooling rate from information obtained from the conical specimen for shallow-hardening steels.

The hardenability of a steel may be designated by a code indicating the distance from the quenched end in which the hardness exceeds the hardness required for obtaining an acceptable quenched-and-drawn structure. For example, the index for a steel that hardens above Rockwell C 50 out to 1½ in. (24/14 in.) from the quenched end would be *J*50-24.

To determine standard hardness curves when only small-diameter bars are available, an insertion method, similar to that of F. E. McCleary & R. Wuerfel [see Metals and Alloys, Vol. 14, Nov., 1941, pp. 794, 796] is used. MS (4)

Checking Controlled Atmospheres

"Carbon Pressure Control of Furnace Atmospheres." John R. Gier (Westinghouse Elec. & Mfg. Co.) *Steel*, Vol. 109, Dec. 22, 1941, pp. 54, 56. Descriptive.

A hot-wire gas analyzer has been developed enabling the operator to preadjust his furnace atmosphere to that point where its carburizing power just matches the carbon-escaping tendency of the steel, thus preventing carburization or decarburization of the steel surface being hardened.

When the steel is heated above its critical range to 1700°-1800° F., it will absorb carbon until its "carbon pressure" (carbon-*escaping* tendency) equals the carbon pressure (*carburizing* potential) of the gas mixture in which heating is done. As the amount of carbon that will be absorbed depends on the carbon pressure of the gas, this value can be used as a measure of carbon pressure. The electrical resistance of the steel can be used to measure accurately the amount of carbon absorbed, because the electrical resistance of steel suddenly cooled from above its critical range is a sensitive function of its carbon content.

In practice, a thin steel wire in a glass tube is heated by an electric current to 1800° F. in a slow stream of test gas from which it absorbs carbon until the carbon pressures are equal. The temperature of the wire is estimated by the amount it sags from an initially taut position when cold, the wire being suspended horizontally between two spring contact electrodes in opposite ends of the tube. A reel carries a supply of fresh wire at one end of the tube, while a second reel at the opposite end serves as a rewind for used wire.

It takes 5-10 min. for the carbon pressures of wire and gas to become equal. Then the wire is cooled suddenly by shutting off the electric current. The heated portion of the test wire is drawn into position between a pair of spaced electrodes outside and just below the tube.

This section of the wire is made part of a bridge circuit and its electrical resistance is read on a rheostat dial when the bride is in balance. An empirical curve showing the relation of wire resistance to equilibrium carbon content of the steel heated at a given temperature in the same gas is employed to read the carbon pressure. The amount and direction of deviation of the carbon pressure from the desired value can then be determined and the gas adjusted accordingly. MS (4)

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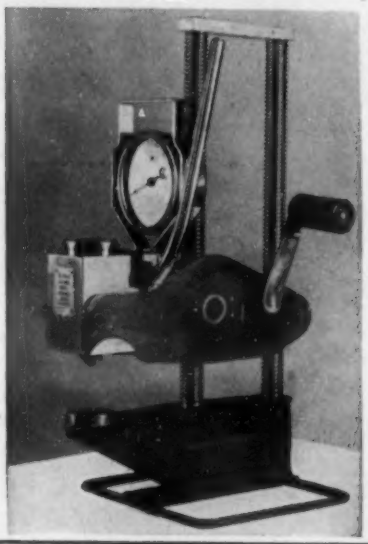

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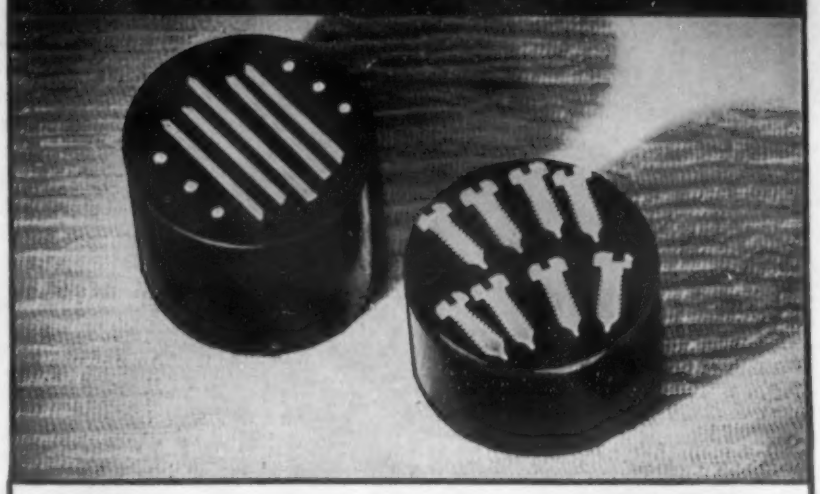

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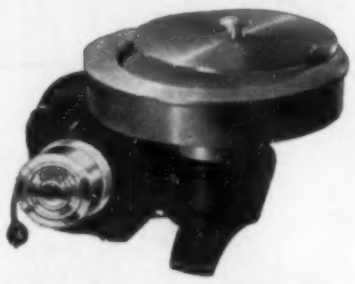

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Magnetic Inspection of Aircraft Parts

MAGNAFLUX AIRCRAFT INSPECTION MANUAL. *By F. B. Doane & W. E. Thomas. Published by Photopress, Inc., Chicago, Ill., 1941. Cloth, 6¼ x 9¼ in., 193 pages. Price $1.75.*

This book contains a reasonably complete description of the magnaflux test and the test equipment as used in the inspection of aircraft power plants and their accessories. It does not, however, adequately cover the inspection of airplane parts such as fittings, welds, landing gears, arresting gears and similar parts that are vitally important in aircraft construction.

The subject matter covered is presented in a well organized manner, the illustrations are numerous and enlightening, and the magnetizing currents recommended should prove a valuable guide to anyone having no previous experience with the test.

The description on page 157 of the method of testing engine mounts is not complete without a warning as to the difficulty of demagnetizing such parts with the standard equipment. For this reason such parts are often magnetized with a.c. which leaves practically no permanent magnetism. The magnetizing current values given, starting on page 101, are considered somewhat high. There is no mention here whether these current strengths apply to the continuous or residual method of test and without this information much of the value of the data is lost.

—R. R. MOORE

Physical Metallurgy

THE PRINCIPLES OF PHYSICAL METALLURGY—SECOND EDITION. *By Gilbert E. Doan & Elbert M. Mahla. Published by McGraw-Hill Book Co., New York, 1941. Cloth, 6½ x 9¼ in., 388 pages. Price $3.50.*

The first edition appeared in 1935. The second has been enlarged by the addition of some 50 pages and 40 figures to bring in new matter, such as the "S" curve. Living up to its title, the second edition, like the first, utilizes the theoretical rather than the engineering approach. It is definitely a text book.

In a book of such length that the student can be expected to assimilate all of it in a school year, few topics can be dealt with very completely. The aim is to give a bird's eye view in the text and list "selected literature" at the end of each section for those who need to go more deeply into that topic.

The contents are, of course, pretty much the same as those of a score of other books in the field, and like most of them, will serve adequately to impart the fundamentals.

—H. W. GILLETT

Machining Manual

NEW ENCYCLOPEDIA OF MACHINE SHOP PRACTICE. *Edited by George W. Barnwell. Published by Wm. H. Wise & Co., Inc., New York, 1941. Cloth, 5¾ x 8¾ in., 568 pages. Price $1.98.*

This very good "shop practice" guide, edited by a professor of production practice at Stevens Institute, contains much of interest and utility to the metallurgical engineer responsible in any way for machining operations or the quality of machined parts.

In fact, the relatively large amount of space (7 chapters out of 16) given over to metals as engineering materials and to several metal-working operations (pressing, stamping, heat treating, welding, forging, foundry work and inspection) other than machining indicates the increasingly close interrelation among them all and the growing trend toward consideration of the whole group, including machining, as a set of unit operations ideally suited to unified, correlated technical control and supervision. The editor of the book clearly recognizes that a knowledge of the materials being machined and of their forging, heat treating, etc. is a prerequisite to successful machine shop operation.

Some metallurgical engineers will use the book as a handy and evidently authoritative guide to some of the details of machine work that they should know before specifying materials and processes. An even larger number will welcome the combining *in one book* of concise, useful information on materials, their machine-working, and the associated operations.

In addition to the topics listed above, there are individual chapters on turning, thread cutting, milling and grinding, special machine tools, gear-cutting, etc. The only important skimping we notice is the small amount of space given to cutting-tool materials.

—FRED P. PETERS

Silver in 1941

TWENTY-SIXTH ANNNUAL REVIEW OF THE SILVER MARKET. *Published by Handy & Harman, New York, 1941. Paper, 5 x 7 in., 15 pages. Free to those interested.*

U. S. production of silver in 1941 was 70 million ounces; industrial use in the U. S. and Canada was 80 million ounces, of which less than 4 million was in Canada. That is, the U. S. used industrially more silver than was produced within its own borders.

Canada produced 22 million, Mexico 79 million, Central and South America 32½ million. Actually, the industrial silver used was produced by our neighbors, since the U. S. production was purchased by the Treasury, along with an equal amount of foreign silver.

We have a stock pile of at least one metal, and the indications are that it will be put to good use not only as the standard "silver solders," but also in high-lead low-silver solder to replace tin solder. Industrial use doubled in 1941 over 1940.

—H. W. GILLETT

Other New Books

VOCATIONAL AND PROFESSIONAL MONOGRAPHS—NO. 33: METALLURGY. *By Robert S. Williams. Published by Bellman Publishing Co., Inc., Boston, 1941. Paper, 6 x 9 in., 12 pages. Price 50c.* The author, M. I. T. Metallurgy Dept. head, outlines qualifications, employment opportunities and career possibilities for the "metallurgist." Somebody ought to do the same thing for the broader field of the metallurgical engineer—the engineer who isn't a professional metallurgist but leans heavily on metallurgy in his work.

POWDER METALLURGY—A REVIEW OF ITS LITERATURE. *Revised Edition. By Clark B. Carpenter. Published by Colorado School of Mines (Colorado School of Mines Quarterly, Vol. 36, No. 4) Golden, Colo., 1941. Paper, 6 x 9 in., 55 pages. Price 50c.* A definite improvement over the still very good first edition (reviewed in the Feb. 1941 issue of METALS AND ALLOYS, page 241), with some rearrangement and considerable additional material. Over 100 references, up to July 1941.

TRAINING OXY-ACETYLENE WELDING AND CUTTING OPERATORS—INSTRUCTORS' OUTLINES. *Published by International Acetylene Assoc., New York, 1942. 88 pages. Price, paper-bound—25c; cloth-bound—75c.* Outlines information needed for training general welders, aircraft welders, pipe welders, cutting operators and inspectors. Lectures, study assignments, practical work, etc., are suggested.